Balancing on Ice:
The Implicit Learning of Tacit Knowledge

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Due to mushrooming research activity, Antarctic science projects and associated deployment of personnel involve high levels of financial investment and demand for outcomes. Although much has been studied about the adaptation of Antarctic sojourners in isolated and confined extreme (I.C.E.) environments since the 1970s, no literature to date looks at implicit learning of tacit knowledge at polar workplaces. In particular, gaps in the research literature regarding informal workplace learning in the polar environment make this thesis exploratory research.

This research employs a case study approach to investigate task, emotional and social-related learning by the support personnel and scientists who went, through New Zealand Antarctic programmes, to work and live in Antarctica between 1970 and 2009. Through the data collected from an open-ended questionnaire, semi-structured in-depth interviews, archival materials and secondary sources, conceptual models and theories were reviewed in light of the learning environment, content and processes perceived by polar personnel.

Despite the fact that tacit knowledge gained by the respondents is highly contextual, the findings suggest that the manner in which gaps in knowledge are closed relates to three aspects: the learning environment, learner characteristics and temporal factors. That is, individual characteristics interact with both the context and the content of the knowledge to be acquired to influence the process by which implicit learning takes place. The data also indicated necessary revisions to the originally proposed models and concepts; specifically, implicit learning showed a *non*-linear process across time. As well, because of the variability of the social environment, and its inherent interdependence on other people, social knowledge appears to be the content area that is most diverse, as reported by the participants.

Consideration of these findings led to an integrated model for polar workplaces and recommendations for future applications and research. In addition to providing Antarctic

sojourners a framework to monitor one's own learning process, these models offer managers of Antarctic programmes a way to facilitate informal workplace learning through human resource practices and workplace design. Going beyond a primarily New Zealand cultural context, and the decidedly unusual physical environment (the polar region) of the current study, future research should employ a holistic and longitudinal approach to examine these models cross-culturally in other Antarctic programmes, I.C.E. and conventional workplaces.

As knowledge workers, Antarctic sojourners conduct cutting-edge science in a region that is becoming important globally. By unfolding the complex, multifaceted and vibrant nature of implicit learning, this thesis contributes to theoretical knowledge, as well as offering more practical advice bearing on the adaptation of polar personnel.

Keywords

Informal workplace learning, implicit learning, tacit knowledge, Antarctic sojourners, polar workplace

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Chapter 1
Introduction

1.1 Significance and Scope of Study

1.1.1 Tacit Knowledge in a Workplace and Organisational Learning

Knowledge is increasingly regarded as the most critical resource of firms and economies (Engelbrecht, 2000; Drucker, 2003; Davenport, 2005). Successful knowledge-intensive firms are characterised by their sustainability in creating 'new knowledge' or 'innovation', and by their quick and efficient application of this information in the creation and delivery of new products, services and organisational systems (Argote & Ingram, 2000; Kelloway & Barling, 2000; Albino et al., 2001; Illeris, 2004).

Organisations that recognise the importance of knowledge and organisational learning place an emphasis on the innovation of information technology and the re-engineering of workplace systems to better manage their intellectual capital and people (Dowling & Welch, 2004; Werner & DeSimone, 2009). Therefore, it is not surprising that the literature of management and organisational science for the last 30 years is peppered with references to learning organisation and culture, knowledge management, emotional intelligence in the workplace and human resource development systems (Collins & Porras, 1997; Argote & Ingram, 2000; Kelloway & Barling, 2000; Albino et al., 2001; Brézillon & Pomerol, 2001; Collins, 2001; Illeris, 2004; Zeidner et al., 2004; Davenport, 2005; Werner & DeSimone, 2009). As shown in Figure 1, below, human resource development systems within an organisation can be divided into four levels: organisational development, career development, training and development, and individual development (DeSimone & Harris, 1998; Werner & DeSimone, 2009).

Two types of knowledge in the workplace are widely discussed in empirical studies: tacit (or personal or implicit) knowledge and explicit (or organisational or codified) knowledge (see Figure 1). While explicit knowledge is said to be acquired, shared, transferred and created through formal organisational systems, such as organisational and collective learning in the workplace (Argote & Ingram, 2000; Albino et al., 2001; Illeris, 2004; Zeidner et al., 2004), tacit knowledge refers to the knowledge that is "usually not openly expressed or taught" (Wagner & Sternberg, 1985, p. 536). Both types of knowledge are critical for organisations and their workforce (Busch, 2008). In the theory of knowledge-creating companies proposed by Nonaka & Toyama (2003) and Nonaka (2005), the development of new organisational knowledge occurs via continuous interactions

between tacit knowledge and explicit knowledge. This leads to four approaches to organisational learning: socialisation, externalisation, combination and internalisation. Socialisation occurs when tacit knowledge is passed on, or generated, through social interactions. Externalisation is when tacit knowledge becomes, or leads to, explicit knowledge. Combination represents the situation in which explicit knowledge creates other explicit knowledge. Finally, internalisation is when explicit knowledge leads to tacit knowledge.

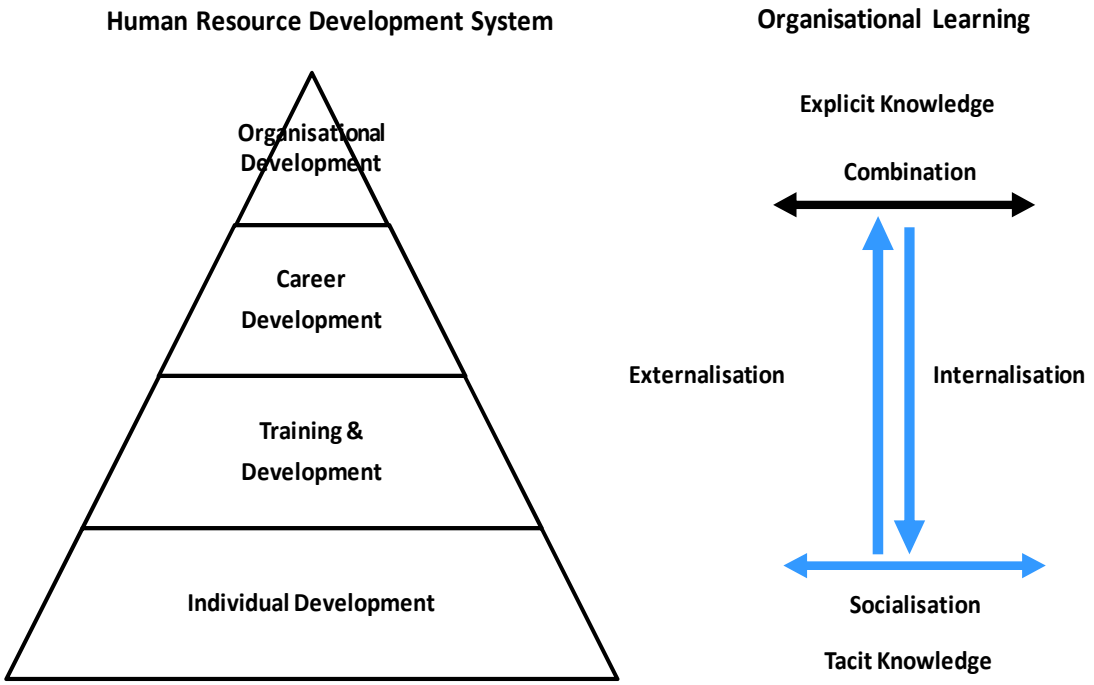

Figure 1: Human Resource Development and Organisational Learning – Tacit Knowledge During Internalisation, Socialisation and Externalisation

Sources:
DeSimone & Harris (1998); Argote & Ingram (2000); Nonaka & Toyama (2003); Bierema & Eraut (2005); Nonaka (2005); Werner & DeSimone (2009)

Current formal human resource development systems, in particular training and development programmes, recognise that knowledge development and management is important for knowledge-intensive firms (Bierema & Eraut, 2005; Werner & DeSimone, 2009). However, these formal systems are generally not oriented toward the tacit knowledge held by individuals in their

organisations (Mott, 2000; McDaniel et al., 2001; Eraut, 2004; Bierema & Eraut, 2005; Clarke, 2005; Busch, 2008; Werner & DeSimone, 2009).

Despite tacit knowledge being one of the underlying elements that form explicit knowledge in the workplace at the individual level, it is difficult to measure in general work settings (Albino et al., 2001; Busch, 2008). A review by Sun, Slusarz and Terry (2005) showed that skill-acquisition literature has been predominantly focused on the top-down models in skill learning (i.e., learning first explicit knowledge and then tacit knowledge), whereas the bottom-up direction (i.e., learning first tacit knowledge and then explicit knowledge or learning both in parallel) has been largely neglected. This is not surprising, given the subjective nature of tacit knowledge and the general mode of acquiring tacit knowledge (i.e., implicit learning and/or non-implicit learning process) (Dienes & Berry, 1997; Cleeremans et al., 1998). Although there has been an enormous amount of implicit learning research conducted in laboratory settings, very little literature deals with sites outside the laboratory walls, and no literature, so far, focuses on the polar workplace.

1.1.2 Rationale for Studying the Polar Workplace

Polar workplace presents an opportunity to develop an inclusive model of implicit learning in an environment that is becoming increasingly important globally. As the threats of climate change and the need to preserve this last natural laboratory on Earth for research increase, so do the needs to conduct Antarctic science (Balham et al., 2008; http://ipy-osc.no/). External stakeholders play a critical role in the Antarctic science and community, politically, scientifically and logistically (e.g., Antarctic Treaty System (ATS), Scientific Committee on Antarctic Research (SCAR), and Council of Managers of National Antarctic Programme (COMNAP) (see Figure 4). Antarctic links in the New Zealand Antarctic Society (http://www.antarctic.org.nz/links.html) further demonstrate the complexity of external stakeholders in the Antarctic community, domestically and internationally. These external stakeholders may affect organisational design, polar workplace and culture, as well as the workforce of Antarctic organisations (Tan & Steel, 2008). Although it is beyond the scope of this study to cover all these issues, it is important to note that individual adjustment to the polar workplace may depend on other organisational systems such as human resource management functions. These functions include human resource planning, job analysis and design, recruitment and selection, performance management system, compensation and reward system, health and safety, industrial relations, human resource development system and human resource information system (Craig, 1996; DeSimone & Harris, 1998; Dessler, 2003; Noe,

2009; Werner & DeSimone, 2009). Changes in organisational systems may initiate changes in organisational culture, which in turn, changes organisational behaviours, and via versa (Noe, 2009; Werner & DeSimone, 2009).

In general, the polar workforce, missions and operations of national Antarctic programmes and other Antarctic-related organisations are influenced, either directly or indirectly, by government's scientific, social-cultural, economic and political interests and strategies, for example, in New Zealand (http://www.antarcticanz.govt.nz/science/science). Due to the development of these organisations, as well as scientific and non-scientific activities in the polar regions, operational, logistic support and manpower practices increased and became more sophisticated over the years (Rothblum, 2001; Fogg, 2007; Balham et al., 2008; http://classic.ipy.org/development; www.comnap.aq/operations/facilities). Trained polar personnel, facilities, communication, technology, clothing and transport became more accessible at stations and field sites compared with earlier years (Harrowfield, 2007; Tan, 2008; Tan & Steel, 2010; www.comnap.aq/operations/facilities).

Due to increasing international collaboration in sharing support and facilities in polar environments, workforce diversity increases from the aspects of socio-cultural and demographic factors, field of expertise and occupational background of polar personnel (Neville, 2007). In addition to the rising number of research stations in Antarctica, the reports presented in International Polar Years Open Conference 2010 showed a significant increase in the amounts and the types of research interests and activities since the First International Polar Year (IPY) (Balham et al., 2008; http://ipy-osc.no/). The number of countries involved in Antarctic research has increased from 11, for the First IPY (1882-1883), to 34 for the Second IPY (1932-1933), to 12 for the Third IGY (1957-1958), and to 60 for the Fourth IPY (2007-2009) (Fogg, 2007; http://ipy-osc.no/; http://www.arctic.noaa.gov/aro/ipy-1/index.htm; http://classic.ipy.org/development/history.htm; http://www.nas.edu/history/igy/).

Although the development of human and social science in Antarctica has come a long way in the past 50 years, physical sciences continue to dominate research activities in these regions, including that by New Zealand (Taylor, 1987; Lugg & Shepanek, 1999; Suedfeld & Weiss, 2000b; Suedfeld & Weiszbeck, 2004; Harrowfield, 2007; Balham et al., 2008; http://www.antarcticanz.govt.nz/science/science-strategy). The literature of polar psychology during the early years focused on social adaptation and psychological selection conducted mainly by Antarctic national programmes and private investigators (Nelson, 1968). Apart from the

application of human adaptation for prolonged deployment to outer space, especially in USA, Russian, European and Chinese space programmes since the 1970s, the development of social science research in polar regions is relatively limited (Andersen et al., 1990; Harrison et al., 1990; Ursin et al., 1991; Dudley-Rowley, 1999; Lugg & Shepanek, 1999; Suedfeld & Steel, 2000; Suedfeld & Weiss, 2000b; Palinkas, 2001a, 2001b; Palinkas et al., 2001; Suedfeld & Weiszbeck, 2004; Harrison, 2005; Nolan, 2005; Tafforin, 2005; Sandal et al., 2007). The challenge of conducting human and social science research in Antarctica continues to this day (Hovelsrud & Krupnik, 2006; http://ipy-osc.no/). For example, only four of 36 human and social science research projects in IPY 2007-2008 were conducted in Antarctica; the rest were related to the Arctic (http://classic.ipy.org/). In other words, an increase of human activities in Antarctica has not appeared to increase the financial and logistic support for human and social science research in Antarctica.

Two issues arise from the above discussion. In order to meet the job demands in isolated and demanding working environments, it is critical for a polar workforce to adapt, learn and apply their knowledge quickly. Implicit learning of tacit knowledge is most likely to take place under this condition. An examination of implicit learning of tacit knowledge by the polar workforce may explain some of the adaptation issues of a polar deployment.

Polar environments are attractive places for the study of tacit knowledge and implicit learning for at least three reasons: the complex and subjective nature of these two concepts is best studied in a relatively simple environment; tacit knowledge is essential for the development of one's abilities in polar workplaces; and research regarding the implicit learning of tacit knowledge is new to the polar regions.

Practical problems in a workplace are often poorly structured and ill-defined; these challenges relate to everyday experience, of personal interest, and demand multiple 'best fit' solutions and methods of selecting this 'best' solution (Hedlund et al., 2002; Neuweg, 2005). As concepts and active skills associated with an action increase in complexity, so do the capabilities of implicit learning (VanLehn, 1996; Mathews, 1997). At an individual level, implicit learning of tacit knowledge may lead to self-regulated, life-long learning (Simons & Ruijters, 2004; Schunk & Zimmerman, 2008). At an organisational level, it may facilitate the intervention of organisational development in the long run (Busch, 2008; Werner & DeSimone, 2009). In other words, tacit knowledge and implicit learning are crucial for an individual and an organisation as a whole because

they are the platform on which explicit knowledge and organisational learning are built (Nonaka & Toyama, 2003; Nonaka, 2005; Busch, 2008; Werner & DeSimone, 2009).

The complex and subjective nature of tacit knowledge and implicit learning can be studied in a more controlled environment, such as a polar workplace, compared with a conventional workplace. The current study uses "conventional workplace" as an antonym of the polar workplace. The polar workplace presents a research opportunity to develop an extensive informal learning model, particularly through incidental learning of tacit knowledge during a polar deployment. Unlike a conventional workplace, the work life of this isolated work community may involve relatively fewer variables or interferences from personal life outside work (Palinkas, 2000, 2002, 2003; Suedfeld & Steel, 2000; Suedfeld & Weiss, 2000b). Firstly, the amount and type of day-to-day activities that individuals have to deal with in this habitat consist of multiple physical, social, and emotional challenges. As there are relatively fewer factors affecting implicit learning data in a polar workplace during a deployment, it is an ideal locale for the study of implicit learning and tacit knowledge. The potential influences may derive mainly from the challenges of isolated, confined extreme (I.C.E.) environments. Physical stressors, psycho-environmental factors, social and temporal factors (Suedfeld, 1987; Palinkas, 2000, 2002, 2003; Suedfeld & Steel, 2000; Taylor, 2002) may affect the acquisition of tacit knowledge by polar personnel. The fact that learning experiences can be clearly defined by the timing of a polar deployment adds value to the use of this context for the current study (D. Paton, personal communication, May 17, 2011).

Tacit knowledge is essential for the development of one's *abilities.* Given the right conditions, these abilities may develop into related *skills,* and subsequently, the *competencies* that one might demonstrate in one's performance at a workplace (Yang, 2003; Werner & DeSimone, 2009; Noe, 2009). This study compares and contrasts the learning experiences of polar personnel. The findings in this context can be used as a reference for implicit learning in other I.C.E. workplaces or deployments. Application of the proposed models in the current study (see Models A, B and Table 5 in Chapter 4) may serve as a yardstick for more conventional workplaces.

Research into implicit learning is new to the polar regions. Antarctic science and polar deployment involve high levels of financial investment and demand for outcomes (http://ipy.antarcticanz.govt.nz/). However, informal, experiential learning by polar personnel can remain tacit and hidden from others, even during the formal 'handover' period. As well, polar personnel appear to experience slightly different social-psychological challenges during the

summer and winter polar seasons, due to the unusual cyclical, situational and social features of the environment (Palinkas, 2002, 2003).

Though third-person measures may capture objective features of an environment, the key to understanding adaptive behaviours lies in an individual's subjective experience of the environment (Dienes & Berry, 1997; Brown, 1998). Such subjective experience may change over the course of engaging in the environment (Frensch & Rünger, 2003). By delineating the modes of acquisition and the utilisation of tacit knowledge by polar personnel, this research seeks to: 1) propose an inclusive model of informal workplace learning, 2) facilitate, improve and support the polar workforce, and 3) contribute to the body of scientific knowledge and a healthier workplace.

A review of the literature across several academic disciplines and fields of study, ranging from organisational and management science, social science, and epistemic studies to cognitive, learning, work, environmental, social and polar psychology between 1960s and 2000s, suggested gaps in the literature in four areas: tacit knowledge, implicit learning, informal workplace learning, and polar adaptation.

On one hand, a wide range of implicit learning research focuses on specific implicit learning behaviours and cognitive processes in laboratories, academic settings and cognitive science studies (e.g., Dienes & Altmann, 1997; Dienes & Berry, 1997; Cleeremans et al., 1998; Cleeremans & Jiménez, 2001; Lieberman, 2000; Block & Griffin, 2000; Frensch & Rünger, 2003; Shanks, 2005; Gaillard et al., 2006). On the other hand, research on tacit knowledge and informal workplace learning looks at learning issues at either individual or organisational levels (e.g., Garrick, 1998; Eraut, 2000, 2004; Fredrickson, 2001; Nonaka & Toyama, 2003; Illeris, 2004; Simons & Ruijters, 2004; Nonaka, 2005).

Further review of tacit knowledge and implicit learning literature suggests the interplay of the following concepts in understanding individuals' cognitive processes and learning behaviour at a workplace: tacit knowledge versus explicit knowledge (e.g., Dienes et al., 1991; Nonaka & Toyama, 2003; Nonaka, 2005), implicit learning versus non-implicit learning (e.g., Cleeremans, 1997; Frensch & Rünger, 2003), implicit memory versus non-implicit memory (e.g., Baddeley & Hitch, 1993; Sun et al., 2005) and explicit application (e.g., Mathews et al., 1989; Baddeley & Hitch, 1993). The current study, however, constrains itself to the investigation of tacit knowledge and implicit learning during the internalisation and socialisation process of informal workplace learning.

Due to the fact that no polar literature has investigated implicit learning of tacit knowledge, the following sections examine the definitions, characteristics, as well as theoretical and empirical

studies of implicit learning, informal workplace learning and tacit knowledge in a conventional environment, as well as social-psychological adaptation in polar regions In order to establish a theoretical framework and methodology for this study.

1.2 Overview of the Chapters

Although internal and external business environmental factors affect Antarctic-related organisations at different levels, this study focuses primarily on the individual learning of polar personnel in national Antarctic programmes and other Antarctic-related organisations in New Zealand since 1970.

The first part of Chapter 1 highlights the rationales of studying implicit learning of tacit knowledge in a polar workplace, followed by an overview of the chapters. Before introducing the research question and objectives of the current study, the theoretical issues and empirical studies related to implicit learning, informal workplace learning, polar adaptation and tacit knowledge were reviewed in order to highlight gaps in the literature, both within and across these academic disciplines. Going beyond long-established research on specific skills learning in the laboratory and non-workplace context, the third part of this chapter seeks to apply implicit learning concepts, models and findings reviewed in informal workplace learning in polar regions.

With the use of contextual approach to study tacit knowledge in polar workplace, the next part of this chapter discusses the research settings: General physical conditions, human activities, and deployment demands in natural and constructed polar environments, in particular, the research stations, field sites and vessels associated to those deployed by Antarctic programmes in New Zealand. These demands prompt the need to investigate what, how, and why polar personnel acquire tacit knowledge in different polar contexts. Through a review of the empirical studies of tacit knowledge between a conventional workplace and a polar environment, three polar abilities were selected for this study: task, emotional and social related knowledge.

In search of the research question and objectives, a theoretical framework was proposed at the end of this chapter: the Informal Workplace Learning Model for Polar Environments, the Adaptive Implicit Learning Model, and the model of Emotional Outcomes from Novice to Expert. These models take into consideration the interplay among learning environments and adaptive learning, as well as learning-associated awareness and affects. These models were analysed and revised in light of the data collected from the respondents in Chapters 3 and 4.

In response to gaps in the literature, Chapter 2 describes the methodological issues and the research design of the current study. The first part of the chapter explains the challenges of investigating tacit knowledge in a polar workplace, followed by why and how the initial research plan was revised from a specific cohort of polar personnel to include a wide range of respondents across polar contexts and deployments. This revised plan employed a triangulation of sources, methods and theories for data collection and analysis. Recruitment and selection of respondents, as well as the administration of instruments and procedures will be discussed. The last part of the chapter provides an overview of the demographics of the respondents before the findings in the following chapter.

Chapter 3 begins with the explanation of the method of data analysis. The chapter presents three major findings from the data collected. In light of the learning patterns reported by the respondents, the first part of this chapter explains how and why the original learning models were revised. From a wide range of learning contents and learning processes reported, the major themes of these findings identify the pull and push factors of learning across polar workplaces. The first part of these findings compares and contrasts the tacit knowledge reported, in terms of the amount, range, frequency, ease of reporting and degree of abstractness of data. The second part demonstrates the perceptions of I.C.E. polar learning environments by the respondents; for example, the work nature of the respondents, small group attributes, and the balance between work and non-work issues. Lastly, it presents the processes associated with the learning task, emotional and social content, as well as the interplay between learning content and a learning process. These include the forms of learning and influencing factors, such as temporal and emotional issues, personality and identity, context intensity and learning intensity. These findings suggest the variances within, and among, the learning contexts may serve as drivers of learning.

The last chapter discusses the findings of the current study and their theoretical and operational implications. The original learning models and concepts proposed in Chapter 1 are discussed and revised in light of the findings. Model A presents physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environment factors in polar workplaces, such as the perceptions of isolation, confinement and extremeness conditions, small group attributes, and the lack of work and non-work borders. These issues include the need for, and the use of scarce resources and privacy. Model B, the core model of the current study, describes the common learning processes that polar personnel may experience during their polar deployment(s): automation, learning-in-action and after-event learning or unlearning. As the primary agent of

one's own learning experience, implicit learning of an individual may be affected by his or her perceptions of unusualness, time, context intensity, learning intensity, identity and affect. Table 5 proposes that the variances of the learning environment, learner and learning transfer, may serve as drivers of learning. The second part of the chapter discusses the implications of task, emotional and social learning for polar psychology. Task, emotional and social learning content demonstrate the demands and constraints of working and living in polar regions. The current study highlights the importance of learning processes and their implications for polar psychology. In light of these discussions, the last part of the chapter presents the recommendations for future application and research.

1.3 Implicit Learning and Learning Environments

By examining the definitions, characteristics, as well as theoretical and empirical studies of implicit learning in a conventional environment, this section seeks to establish a theoretical framework and methodology for the current study.

1.3.1 Contextualism, Selectivism and Phenomenological Approach to Learning Theories

Learning refers to the process involved in acquiring and changing one's knowledge, skills, self-worth, and fundamental cognitive orientation through complex interactions of mind, emotions and environments (Illeris, 2004). Learning curves capture the process of learning across time. The literature about the psychology of learning covers at least five major categories: folk, physiological, behavioural, cognitive and mathematical approaches (Pear, 2001) (see Figure 2, below). Each school offers different ways to study and explain a learning phenomenon (Pear, 2001).

Learning theories and models served at least two functional purposes for this study. First, they provided the terminology and theoretical frameworks for interpreting learning behaviours and cognitive processes at a polar workplace. These frameworks enable individuals to examine more critically the origin of a practical problem, as well as the formulation of solutions to one's problem. Though the current study investigates the learning process that polar personnel might experience during the acquisition of a task, emotional and social knowledge, it is not its purpose to offer strategies to resolve all the adaption issues identified at a polar workplace.

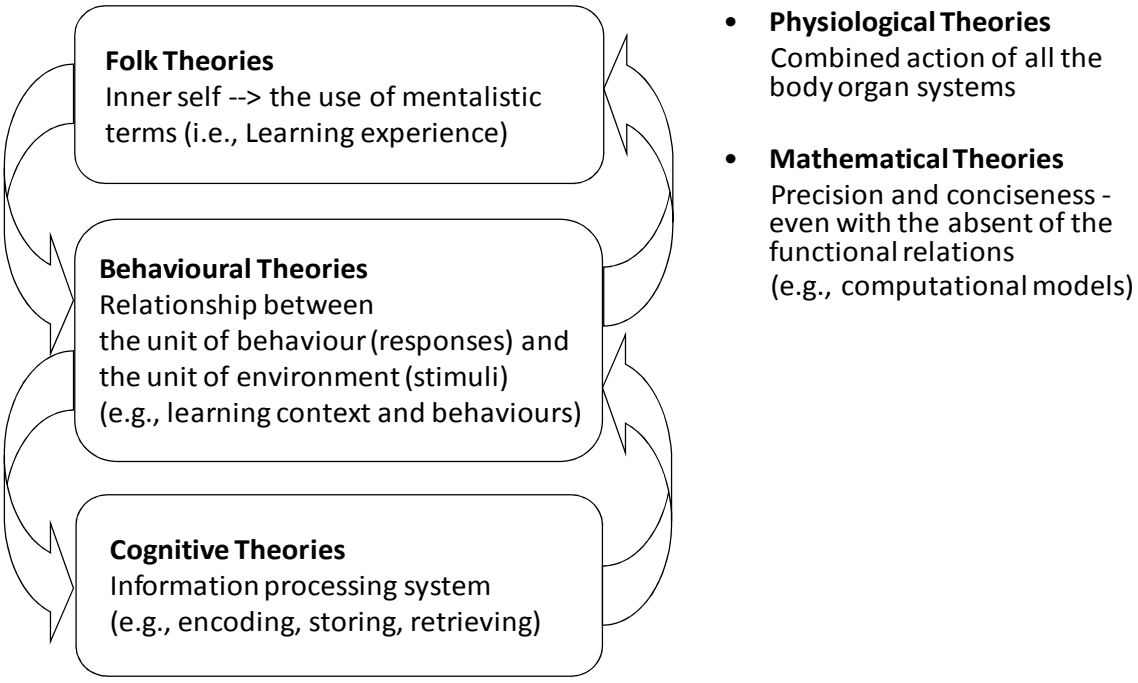

Figure 2:
Circular Approach to Learning Theories
- Behaviourism, Cognitive and Constructivism

Adapted from: Pear (2001)

The study of learning processes in a workplace poses challenges. It involves the study of the external and internal complexity of mind across disciplines and approaches. This includes a hybrid of 'fragile sciences', such as epistemology, philosophy, cognitive science, psychology, human science and human resource development. The *phenomenology approach* proposes behaviours are guided by the 'subjective world' rather than the 'objective world' (Brown, 1998); *depth psychology* includes the *non-conscious mind* in the study of the internal complexity of the mind (e.g., Mathews, 1997; Cleeremans et al., 1998; Cleeremans & Jiménez, 2001; Gaillard et al., 2006). Within each academic discipline, different schools of thought offer a wide range of approaches to inspect the phenomena of individual learning. These theories are categorised into behaviourist, cognitive and constructivist approaches (Pear, 2001). These approaches lead to different forms, scopes and depth of research outcomes, as well as the challenge to examine the findings of learning from cross-disciplinary perspectives.

From the *contextualism* approach of environmental psychology, human behaviour is an intentional act (Altman & Rogoff, 1987; Stokols, 1995). This view implies that learning behaviour may be a goal-directed, purposeful and functional act. An extension of the contextualism approach, the *selectivism* view, further suggests purposive behaviour consists of integrated acts that are associated with the physical and social environment, where changes and the physical being are the central feature of the whole (Altman & Rogoff, 1987). This aspect suggests that purposive acts should be studied as a unity of psychological processes, space and time (Helfrich, 1996; Flatherty, 1999; Perret-Clermont, 2005). This view is crucial for the current study for the following reasons. The learning of task, emotional and social knowledge may engage different properties of knowledge; for instance, the integration of descriptive and procedural knowledge. Secondly, the study of space, processes and time may provide a contextual understanding of individuals' subjective experience in acquiring these forms of knowledge. Thus, selectivism appears to provide a general framework for the study of learning acts, from the perspective of a learner.

1.3.2 Implicit Learning and Associated Factors: Non-implicit Learning, Awareness, Intention, Adaptive Learning and Environments

Despite the fact that tacit knowledge is widely accepted by most researchers, discussion continues about whether the mode of learning tacit knowledge involves implicit learning, non-implicit learning, or a dual process (e.g., Willingham & Goedert-Eschmann, 1999; Sun, 1997, 2002; Mathews et al., 2000; Destrebecqz & Cleeremans, 2001; Sun et al., 2005). Though explicit learning is often associated with intentional, formal learning (DeShon & Alexander, 1996), this study adopts the term "non-implicit learning" (Frensch & Rünger, 2003) for any forms of learning other than implicit learning.

Based on the review of cross-disciplinary literature, such as epistemic studies and psychology (i.e., cognitive, learning, work, environmental, social psychology and neuropsychological studies), as well as organisational and management science, this section provides the background of implicit learning and associated concepts: conscious awareness, adaptive learning and learning environment. It covers the definitions, characteristics and empirical studies related to these concepts.

In his study of artificial grammar learning, Reber (1967, 1993) introduced implicit learning as an alternative to non-implicit learning. This form of learning is distinguished from non-implicit learning in terms of the absence of consciously accessible knowledge (Reber, 1967, 1993). Non-

implicit learning is typically "hypothesis-driven and hence fully conscious" (Cleeremans et al., 1998, p. 506), implicit learning enables the "acquisition of new information without intending to do so" (Cleeremans et al.,, 1998, p. 506) and it may be reinforced by one's intuition (Osbeck, 1999; Lieberman, 2000). This lack of intentionality, or absence from awareness, makes it difficult for an individual to verbalise the resulting knowledge (e.g., Mathews, 1997; Cleeremans et al., 1998; Cleeremans & Jiménez, 2001; Zeidner et al., 2004; Gaillard et al., 2006). Recent research of artificial grammar learning suggested the threats of meaning creation of a behaviour may increase one's attention and intentionality to improve implicit learning of an artificial grammar (Proulx & Heine, 2009). Over the years, debates about the nature of implicit learning have continued since the introduction, by Reber (1967, 1993), of this view of learning.

Empirical studies of brain functions support the distinction between implicit and non-implicit learning. In a study of clinical subjects, amnesia patients showed intact implicit learning but impaired non-implicit learning (Berry & Dienes, 1993). That is, brain areas involved in working memory and attention are more active during non-implicit learning compared with implicit learning (Berry & Dienes, 1993). Recent research about the influence of frontal-mediated working memory processes on implicit and explicit perceptual category learning suggested the dissociation, interrelated and adaptive nature of these forms of learning (Filoteo et al., 2010).

During the last two decades, the enquiry into implicit learning appears to extend from controlled environments, such as laboratories, to the study of everyday life in natural settings. Few, however, looked at workplace learning. Research in natural settings suggested that contextual factors, such as processes, space and time imbedded in the act of learning itself, may influence the degree of intentionality and awareness of learning (e.g., Frensch & Rünger, 2003; Leary & Tate, 2010). Although implicit learning of task, emotional and social knowledge may take place in everyday life (e.g., Sternberg et al., 2000; Leary & Tate, 2010), to date, specific definitions and mechanisms of implicit learning remain inconclusive.

Much of the debate originates in three foci of reviews of implicit learning: empirical findings, methodological issues and theoretical positions (Berry & Dienes, 1993; Berry, 1997; Mathews, 1997; Whittelsea & Dorken, 1997; Cleeremans et al., 1998; Honda et al., 1998; Stadler & Frensch, 1998; Lieberman, 2000; French & Cleeremans, 2002; Gaillard et al., 2006; Woll, 2008). To date, disputes continue in two aspects: 1) the definitions and mechanisms of implicit learning, and 2) the dynamic and complex relationships among people, context and the dynamic process of acquiring and utilising tacit knowledge in the work context and in everyday life.

Over the years, the paradigm on implicit learning has altered from "a mysterious process of passive, automatic and unconscious acquisition of abstract and tacit knowledge" to "a side-effect of on-going learning processing" (Cleeremans et al., 1998, p. 508). This latter definition suggests the degree of awareness of the act of implicit learning may change over time. It also indicates that implicit learning may continue after an initial learning event. That is, the definitions of implicit learning might vary based on the acquisition processes as well as the knowledge resulting from these processes and the retrieval processes (Cleeremans et al., 1998).

1.3.3 Implicit Learning: Empirical Studies, Methodological and Theoretical Issues

Despite decades of debate, a clear depiction of the implicit learning processes is still lacking. This problem is apparent in the empirical studies, methodological issues and theoretical positions of implicit learning. The review of these areas, below, provides a background to the evolution of these definitions.

Part 1: Empirical Studies

Research on implicit learning typically involves several conditions and assumptions. First, implicit learning takes place through incidental learning conditions, often in a complicated, rule-governed environment. Second, the reporting of implicit learning indicates the extent of the subjects' ability to express their newly acquired knowledge about the environment. Finally, this report indicates the extent of subjects' consciousness of the knowledge that they have acquired.

A wide range of experimental paradigms where implicit learning was investigated includes, but is not limited to, the following:

- artificial grammar learning (e.g., Reber, 1967, 1989, 1993; Mathews et al., 1989, 2000; Dienes et al., 1991; Proulx & Heine, 2009)
- sequence learning (e.g., Honda et al., 1998; Destrebecqz & Cleeremans, 2001; Feeney & Howard, 2002; Nagy et al., 2007)
- dynamic system control (e.g., Lebiere et al., 1998; Cleeremans & Jiménez, 2001)
- probability learning (e.g., Reber & Millward, 1968; DeShon & Alexander, 1996)
- control of complex systems (e.g., Berry & Broadbent, 1995; Evans, 2008)
- serial reaction time task (e.g., Nissen & Bullemer, 1987; Smith et al., 2001)
- learning of conditional responses (e.g., Shanks et al., 1994; Goedert & Willingham, 2002)
- acquisition of invariant characteristics (e.g., Berry, 1997; Tillmann et al., 2000)

- perceptual learning (e.g., Chun & Jiang, 1999; Jiang & Chun, 2001; Seitz & Watanabe, 2005) and learning of perceptual categories (e.g., Chun & Jiang, 1998; Filoteo et al., 2010)
- second language acquisition (e.g., R. W. Schmidt, 1990; Hulstijn, 2002)
- the role of the medial temporal lobe structures in implicit learning: an event-related fMRI study (e.g., Rose et al., 2002; Schendan et al., 2003)
- performance in a simple gambling task (the "Iowa gambling task") (e.g., Bechara et al., 1997, 2005)
- facial expression of emotions (e.g., Schultheiss et al., 2005a)

The following section provides an overview of how implicit learning studies were conducted in the first three classic studies.

Artificial Grammar Learning. Pioneered by Reber (1989, 1993), the study of artificial grammar learning demonstrated that respondents can classify a set of letter strings better than chance would predict, yet they were unable to verbally report the rules of grammar that they used in doing so. He suggested that implicit learning is present due to the dissociation between the performance and the verbal report by the respondents. The basic form of this experiment has been repeated using different measures of awareness by many researchers over the years. However, debates on 'learning without awareness' continue, because "none of the criteria used to measure awareness has met universal acceptance" (Tunney & Shanks, 2003, p. 1). Part 2 of this section will explain the disputes about the criteria used to measure awareness.

Sequence Learning. In an investigation of sequence learning, respondents were required to react to a series of events that were visually structured on a computer screen (Cleeremans et al., 1998). When the respondents saw the stimuli appear on the screen, they were asked to press the matching key immediately. Unknown to the respondents, these stimuli were repeated in a pattern that was controlled by a set of predetermined grammatical rules. It was found that the respondents in the structured material condition reacted faster than the respondents in the random material condition. However, the respondents who reacted faster also failed to demonstrate knowledge of the pattern. This finding demonstrated that implicit learning took place without the awareness of an individual.

Dynamic System Control. In experiments investigating dynamic system control, respondents are generally given a multiple-round, interactive computer task to complete. One of the classical examples is a sugar factory where a list of inputs (e.g., numbers of workers) that may

affect the outputs (e.g., the amount of sugar produced by the factory) was provided to the respondents (Lebiere et al., 1998; Cleeremans et al., 1998). These respondents expected to manipulate the inputs in order to meet a specific goal level of sugar output. By calculating the recorded interactions, a formula was developed based on the connections between the input and the output variables. Using a post-experimental structured questionnaire, it was found that the respondents who achieved a good level of control of the system reported a lack of ability to specify the rules of the system. In other words, both the sequence learning and dynamic system control experiments demonstrated the existence of implicit learning.

Research into implicit learning has also included motor skills and performance (e.g., R. A. Schmidt & Wrisberg, 2005; Orrell et al., 2006), facial expression and social learning (e.g., Bechara et al., 1997, 2005; Schultheiss et al., 2005a), and implicit learning in a workplace (e.g., Eraut, 2000; 2004; Bunniss & Kelly, 2008). Other implicit learning studies have been conducted within organisational studies (e.g., Berings et al., 2005; Busch, 2008). Compared with experimental studies, a lack of implicit learning literature in natural settings makes extensive discussion difficult.

Most empirical studies in both categories of settings agree on the existence of implicit learning but disagree on the mechanism of implicit learning. The following section reviews the methodological issues that appear to be the sources of the disputes in the implicit learning literature.

Part 2: Methodological Issues

The studies above demonstrate the existence of implicit learning across dissimilar subjects, settings, measures and procedures. Yet, they occasionally contradict each other with regards to how such learning may be initiated and developed. Two reasons call for an examination of the methodological issues for the purpose of the current study. First, a review of these issues helps to explore and explain how a research design and method used in an implicit learning study may contribute to its findings. This takes into account the limitation of using a third person approach to capture the dynamic nature of an implicit learning process in a context; namely, a learner's subjective experience. This issue will be discussed further in Chapter 2. As the current study deals with a cross-disciplinary topic related to human subjects, methodological issues will be now be reviewed in order to highlight the contextual nature of the implicit learning process, and to find ways of increasing Type 1, 2 and 3 validity (Silverman, 1993).

Subjects. A wide range of implicit learning studies focused on the learning experiences of non-clinical subjects. Besides the awareness of a learning process, these studies investigated the learning experiences of specific knowledge and/or skills required to perform a task. These researchers employed self-reported and/or observable learning behaviours and performance. Implicit learning was tested in controlled and non-controlled settings across demographic factors, such as age, intelligence and sex (e.g., Maybery et al., 1995; Curran, 1997; Schultheiss et al., 2005b). Apart from the indistinguishability of implicit learning by age, findings in these areas appear to be inconclusive regarding other demographic characteristics.

Other studies investigated patients who suffered from brain impairments or neuropsychological syndromes, such as amnesia, Parkinson's disease, Huntington's disease, mental retardation, schizophrenia and strokes (Lieberman, 2000; Danion et al., 2001; Smith et al., 2001; Yori et al., 2002; Orrell et al., 2006; Schmitter-Edgecombe, 2006). Once again, the results were generally inconclusive, though the evidence for implicit learning was reasonably supportive. To explain this lack of differentiation among disparate groups, Frensch & Rünger (2003) suggested individuals' cognitive and psychological development could be the key to these discrepancies.

The following section reviews the research settings, procedures, measures and criteria used in previous studies.

Settings. The majority of implicit learning studies conducted in controlled settings, such as laboratories, employed experimental methods to investigate implicit learning of specific and pre-determined tasks (e.g., Reber, 1967, 1989; Diene et al., 1991; Mathews et al., 1989, 2000). On the other hand, studies in natural settings acknowledge the importance of implicit learning in everyday life, such as complex skills learning, encoding non-verbal messages, and creative problem-solving abilities (Mathews, 1997; Lieberman, 2000; Marsch et al., 2006; Woll, 2008). Practical problems in a natural setting, such as a workplace, are more likely to be poorly structured and ill-defined, relate to personal interests, and in need of multiple 'best fit' solutions and ways to select the 'best' solution (Hedlund et al., 2002; Neuweg, 2005; Sternberg & Wagner, 1986; Sternberg et al., 2000; Woll 2008). When cognitive and active skills involved in performing a task become more complex, so does the process to learn these skills (Mathews, 1997; Frensch & Rünger, 2003).

Although the majority of studies agreed on the importance and the existence of implicit learning in controlled environments and natural settings, criticism of the methodology used, and its lack of external validity, remain unresolved.

Procedures, Measures and Criteria. The measurement of implicit learning, one of the most heated debates in the implicit learning literature, continues to be a challenge for many researchers. Recent research interest focused on which criteria to use to measure implicit learning, and which method to administer in order to ensure the validity of the implicit learning findings (Cleeremans at el., 1998; Cleeremans & Jiménez, 2001; Destrebecqz & Cleeremans, 2001; Jiménez, 2002; Tunney & Shanks, 2003; Gaillard et al., 2006; Ziori & Dienes, 2006). In general, it is recognised that prior knowledge of the subject might direct or facilitate people's attention in the acquisition of tacit knowledge and explicit knowledge. Disputes continue about whether the same principle applies to implicit learning.

A claim for implicit learning depends on the specific criterion chosen to assess the awareness of performing a particular task. Subjective measures or a first-person approach, such as retrospective verbal report and verbal introspection, were often used to measure awareness. Objective measures or a third-person approach, such as yes/no responses, key presses and response latencies, were some of the methods used to observe the performance of a task. Any dissociation between performance and awareness is thought to indicate the presence of non-conscious cognition (Gaillard et al., 2006). Most implicit learning studies have taken the form of dissociation paradigms to demonstrate the existence of implicit learning by showing that some learned tasks are performed without the subject's awareness of the acquired knowledge (Gaillard et al., 2006).

These methods seem simple, yet they may create complications for the study of implicit learning for the following reasons (Gaillard et al., 2006). The first concerns definitional issues, such as what is meant by the term 'consciousness'. In contrast to researchers who claim that an individual is either aware or not aware of what and how he or she learns a piece of knowledge, some researchers propose consciousness varies by type, dimensions and degrees (Block, 1995; 2005; Atkinson et al., 2000; Gaillard et al., 2006). This leads to the second aspect: How does one best assesses conscious awareness? Given opposing views about consciousness, as well as the fact that each type of tacit knowledge may involve different level of cognitive and motor skills, it is not surprising that research methods remain an unresolved challenge in implicit learning research. Conceptual issues, such as how one best interprets the dissociation findings, give rise to another dispute in implicit learning research.

Third-person and First-person Approaches. In order to find out what measures can best contribute to the current study, this section reviews two approaches most commonly found across implicit learning literature.

The first method, a third-person approach, measures behaviours and brain processes associated with implicit learning (e.g., Destrebecqz & Cleeremans, 2001; Feeney & Howard, 2002; Nagy et al., 2007; Proulx & Heine, 2009). Most experimental studies of implicit learning discussed in Part 1 of this section employed this approach. This category of methods includes the perceptual discrimination of external stimuli, the integration of information across sensory modalities, automatic and voluntary actions, levels of access to internally represented information, verbal reportability of internal states, and the differences between sleep and wakefulness.

According to Chalmers (2004), one of the limitations of using a third-person approach is its lack of ability to explain the 'objective function' of an implicit learning system. The use of objective measures to assess conscious mental states is said to inherit the same problem as subjective measures, because they measure "not just knowledge, but conscious knowledge" (Gaillard et al., 2006, p. 7) pre-determined by a researcher. Although objective measures seem 'scientifically sound', these measures could not capture the implicit learning of complex tacit knowledge in natural settings (Chalmers, 2004). This implies that a third-person approach may trigger Type 1, 2, and 3 validity errors for the current study.

Because implicit learning may vary among polar personnel, and because such a study is relatively new to the polar literature, an investigation of a wide range of tacit knowledge acquisition appeared to be more constructive for polar research compared with a focus on a specific, pre-determined skill. These reasons, added to the concerns about the effect of third-person methods on validity, indicated that a this approach was not suitable for the current study.

On the other hand, a first-person approach measures individuals' subjective experience associated with consciousness (e.g., Varela & Shear, 1999; Epley & Gilovich, 2001; Tunney & Shanks, 2003; Chalmers, 2004; Destrebecqz & Peigneux, 2005). This category of methods includes the visual experience associated with colour, depth and auditory experiences, bodily experiences such as pain and hunger, mental imagery such as recalled visual images, emotional experiences such as happiness and sadness, as well as occurring thoughts such as the experience of reflecting. A first-person approach is often questioned for its vulnerability in measuring awareness associated with implicit learning. These challenges range from the form and timing of obtaining subjective measures, to the criterion selected to examine the existence of implicit learning (Cleeremans &

Jiménez, 2001; Tunney & Shanks, 2003; Chalmers, 2004; Gaillard et al., 2006; Ziori & Dienes, 2006). Some researchers proposed that verbal-report data alone might not accurately report the presence or absence of implicit learning because they might not always satisfy two criteria: the information and the sensitivity criteria (Frensch & Rünger, 2003; Tunney & Shanks, 2003; Chalmers, 2004; Gaillard et al., 2006; Ziori & Dienes, 2006). *Information criteria* refer to the information assessed by verbal recall tests that is not always the same information that demonstrated learning. *Sensitivity criteria* refer to one's lack of awareness towards what and how something was learned.

Although some researchers have suggested using objective measures, such as forced-choice tests, to supplement verbal reports, others introduced different subjective measures, as described below.

Guessing Criterion of Awareness. **The** guessing criterion was introduced as an alternative measure to the free verbal report as a means to resolve the problem of 'response bias', by sensitively measuring conscious and non-conscious knowledge (Dienes & Berry, 1997*;* Ziori & Dienes, 2006). Respondents were asked to report their subjective experiences by the means of confidence ratings. In order to estimate the overall level of accuracy, respondents were required to make discriminations before rating their confidence level on the accuracy of their judgment.

Zero-correlation Criterion or Zero Confidence-Accuracy Relationship Criterion. The zero-correlation criterion associates with the concept of calibration in probability estimation (Dienes & Berry, 1998*;* Tunney & Shanks, 2003). This criterion measures respondents' accuracy in estimating the probability of an event. They are 'well-calibrated' if the estimation is accurate. Over or underestimation of the probability of an event is considered as 'poorly calibrated'.

Trial-by-trial Confidence Ratings Based on Signal Detection Theory. Signal Detection Theory was introduced as an alternative to the guessing criterion in an artificial grammar learning task in order to explore whether respondents know when they are correct and when they are incorrect about the information that they used to classify sequences (Kunimoto et al., 2001; Tunney & Shanks, 2003). Respondents are expected to report on their subjective experiences by means of confidence ratings. Reporting should correlate with a high confidence for correct decisions and low confidence for incorrect decision. Confidence should, therefore, be related to accuracy.

In contrast, respondents who lack of the awareness of the information they are using, may report a confidence level on a random basis. A mismatch between the reported confident level and the information indicates disassociation between these two measures. In this case, confidence will be unrelated to accuracy. These binary confidence judgments can then be categorised using Signal

Detection Theory with four possible readings: hit, false alarm, miss, and correct rejection. Unlike the use of the free verbal report, this is said to be a useful method because the sensitivity of the measure is unaffected by the respondents' own report criteria. Therefore, it may be independent from response bias.

Some of these methods, however, may not be appropriate or practical for the current study. The review above prompts a need for the current study to examine the theoretical positions related to consciousness and implicit learning in the following section.

Part 3: Theoretical Positions Related to Consciousness and Implicit Learning

The disputes on empirical findings and methodological issues discussed above are derived from the theoretical positions adopted for the study of implicit learning: consciousness and the mechanisms of implicit learning (Mathews, 1997; Cleeremans et al., 1998; Georgief & Jeannerod, 1998; Destrebecqz & Peigneux, 2005; Gillard et al., 2006; Norman, 2010). The following section reviews these two areas from the viewpoint of cognitive philosophy and psychology.

Consciousness and Memory. As it is not the purpose of this research to enter into the debate regarding the nature or existence of the unconscious, the term 'non-conscious' or 'lack of awareness' will be employed in the current study to indicate the condition where learning takes place without awareness of such learning occurring.

Following his introduction of implicit learning, Reber (1967) proposed that implicit learning occurs when the sum of information in the non-conscious domain is more than that in the conscious domain. This is based on the assumptions that there are two forms of memory (i.e., implicit memory and non-implicit memory) and subsystems that can be mapped across these domains (Knowlton & Greenberg, 2008). Two types of processing for these memory systems were proposed, namely, implicit cognition and non-implicit cognition (Reber, 1993; Underwood, 1996; Sun, 2002). A non-attendance mode of processing, implicit cognition received criticism from other researchers who essentially claimed that it is not possible to switch off conscious awareness in non-clinical subjects (Cleeremans, 1997). In other words, associations between implicit learning and non-implicit learning are anticipated with the non-clinical subjects (Cleeremans, 1997). This position implies that it is virtually not possible to demonstrate the existence of implicit learning. In order to make it less problematic for implicit cognition to be the default, Cleeremans (1997) introduced implicit learning principles. One of the principles suggests that the implicit and explicit distinction does not necessarily reflect an "architectural dichotomy" (Cleeremans, 1997, p. 2).

In other words, the assumption that a given piece of knowledge is either in the 'non-conscious' box or in the 'conscious' box, would be flawed if there were simply no such boxes (Cleeremans, 1997).

Some researchers have suggested that some of the cognition models to date still lack the capability of explaining the complexity of implicit learning phenomena (Cleeremans, 1997; Georgief & Jeannerod, 1998; Cleeremans & Jiménez, 2001; Barsalou et al., 2003; Gaillard et al., 2006). According to these researchers, the contemporary assumption about cognition emerging through the operation of "a symbolic processor that essentially fetches information from separable knowledge database, processes it and then sends it to some other module for further processing or action" (Cleeremans, 1997**,** p. 2), leaves no room for implicit learning. This "… 'warehouse, truck and factory' metaphor of cognition needs revision in order to explore alternative ways to think about some of the central issues in implicit learning research." (Cleeremans, 1997, p. 2). Along this line, some researchers offered ways to map consciousness on a theoretical landscape (Atkinson et al., 2000). This approach proposed consciousness is complex and dynamic.

The review above highlights two major challenges faced by implicit learning theorists. To close the divide between phenomenology and behaviour (and its measurement) requires an understanding of: 1) the nature and operation of consciousness, and 2) the definition of measurable behaviour related to a given phenomenological concept, for example, implicit learning (Cleeremans, 1997). Although, over the years, implicit learning research has shifted from phenomenological definitions towards objective definitions of implicit learning, it is still difficult to pinpoint the causes that underline the observed behaviour because it involves multiple determinants (Cleeremans, 1997; Gaillard et al., 2006). Due to a lack of similarly detailed theories about the mind (Hofstadter & Dennett, 1981, Crane, 2000, Dennett, 2005), the second challenge is to detect the cognitive processes that construct an observed behaviour (Cleeremans, 1997). Closing this gap requires an understanding of the underlying mechanism that might form the behaviour (Cleeremans, 1997; Frensch & Rünger, 2003; Gaillard et al., 2006).

Graded Consciousness and Implicit Learning. According to Cleeremans & Jiménez (2001), consciousness is not a "unitary phenomenon" (p. 6) or an "all-or-none process or property" (p. 9). Some researchers proposed that consciousness is graded and dynamic, because it offers many dimensions and degrees of measures (Block, 1995, 1996, 1999, 2005; Atkinson et al., 2000; Cleeremans & Jiménez, 2001; Rosenthal, 2002; Norman, 2010). That is, consciousness comprises different but interrelated dimensions: phenomenal conscious, self-consciousness, access-consciousness and monitoring consciousness (Block, 1995, 1999, 2005).

The most problematic aspect of consciousness is *phenomenal consciousness* (Block, 1995, 1999, 2005; Cleeremans & Jiménez, 2001; Rosenthal, 2002; Norman, 2010). It is proposed that *phenomenal consciousness* enables information processing associated with *qualia* - "the elements of conscious imagery feelings, or thought that together appear in our mind to form a coherent impression of the current state of affairs" (Cleeremans & Jiménez, 2001, p. 7). In other words, it refers to the unprocessed feelings of an experience (Norman, 2010). Along this line, Rosenthal (2002) proposed dividing *phenomenal consciousness* into thin and thick phenomenology – a field that seems to have recently attracted on-going studies (Lane & Liang, 2010). According to Rosenthal (2002), thin phenomenology takes place when an individual separates from being conscious of one's own self. Thick phenomenology comprises a subjective manifestation of phenomenology – an episode that transpires mainly in higher-order-thoughts (Rosenthal, 2002). The existence and definition of qualia continue to receive opposing views among the philosophers (Gelwick, 1977; Hofstadter & Dennett, 1981; Hubbard, 1996; Gustafson, 1998; Jakab, 2000; Rosenthal, 2002; Amoroso, 2003; Dennett, 2005; Mandler, 2005; Blackmore, 2006; Norman, 2010). The first group supported the existence of sense-data. This group proposed the difference in experience, qualitatively, between conscious and non-conscious processes. It derives from naturalism that dominated philosophy in the last 40 years. The second group suggested removing sense-data theories and rejected the existence of qualia (i.e., qualia is not the properties of public or objective properties). Some researchers question the adequacy of the methods used in current cognitive science to investigate consciousness (Atkinson et al., 2000; Crane, 2000; Norman, 2010). Although it is beyond the scope of this study to discuss these in-depth, the discussion about qualia continues to influence the study of consciousness and, therefore, implicit learning.

The second type of consciousness, *self-consciousness*, refers to the possession of the concept of the *self* and the ability to use this concept to introspect one's own mental states (Block, 1995, 1999, 2005). Research in *self, identity and perception* showed the interrelationships of these concepts (e.g., Brown, 1998; L. L. Schmidt et al., 2005). Introduced by Jacques Lacan in 1936 (Ragland-Sullivan, 1986), the *mirroring effect* proposes that the existence of *self* may be discerned through reflection. Self Discrepancy Theory (Higgins, 1987) further suggested that an individual may 'observe' *self* differently at different points in time. In other words, possible selves can be plotted or mapped on a continuum (e.g., Strauman, 1996; L. L. Schmidt et al., 2005), in order to formulate identity indices. Different mental models can form the phenomenological self of identity indices.

Chapter 3 will present the issues about self, identity and perception associated with implicit learning in polar environments.

This capability to introspect *self* indicates the present of the third type of consciousness – *access-consciousness. Access-consciousness* refers to retrieving information about *self* so that an individual can reason and steer his or her own communication and act accordingly (Block, 1995, 1999, 2005). Perhaps by default, not all the above consciousness is noticeable by an individual at all times, namely the presence of *monitoring consciousness.* This internal monitoring process of own state of self may be found in three forms (Block, 1995, 1999, 2005): 1) the inner perception in a form of phenomenon consciousness, 2) the internal scanning in the form of information processing, and 3) the metacognitive notion in the form of higher-order-thought.

Despite decades of disputes about different types of consciousness, the process whereby one learns about his or her own mental state demonstrates three characteristics. As discussed above, graded consciousness may be highly dynamic. "What I am aware now I might be unaware of at the next moment." (Cleeremans & Jiménez, 2001, p. 12). This may include a flash of feeling in the case of higher-order thoughts (Rosenthal, 2002). In addition, graded consciousness may be contextualised: "What I am aware of at some point in time when learning a new skill is not identical with what I will be aware of after I have mastered the skill" (Cleeremans & Jiménez, 2001, p. 12). Lastly, graded consciousness may be personal. An individual may develop affective responses associated with a learning outcome resulting from his or her subject experience (Eraut, 2000; Fredrickson, 2001, 2004; Simons & Ruijters, 2004). In other words, instead of a static entity, consciousness may be a personal, subjective, graded and dynamic process (Block, 1995, 1999, 2005; Cleeremans & Jiménez, 2001). For the current study, this perspective indicates that polar personnel may go through different learning stages and conceptual complexities in becoming aware of their task, emotions and social learning, when they transform from novices to old hands.

From the aspect of information-processing, computational modelling of implicit learning receives much attention, for example, in the studies of sequence processing, artificial grammar learning and dynamic control systems (Cleeremans et al., 1998; Sun et al., 2005; Perruchet & Pacton, 2006; Norman, 2010). The most influential families of models thus far are neural-network models and fragment-based models (Cleeremans et al., 1998).

Fragment-based models, such as Servan-Schreiber and Anderson's Competitive Chunking Model (1990), assumed a continuous process of chunk creation and application (Cleeremans et al., 1998). Specifically, the Competitive Chunking Model proposes that individuals identify, categorise

and utilise the outcomes of incidental artificial grammar learning faster in grammatical strings compared with non-grammatical strings (Servan-Schreiber & Anderson, 1990). Further study by Buchner (1994) proposed that the pace of making a recognition judgment of such nature may depend on one's prior responses to a similar context. This feeling of familiarity may not necessarily stimulate grammatical judgments in a consistent pattern (Buchner, 1994). This implies that the chunking model may fall short in understanding the dynamic nature of consciousness associated with such learning.

On the other hand, neural-network models proposed that consciousness consists of stable representations and a cognitive system consists of many interconnected modules (Cleeremans et al., 1998). Each module is made up of "a feed forward mapping network and of a constraint satisfaction network" (Cleeremans et al*.,* 1998, p. 8). These attractors connect to well-formed units of the domain. When the input is only momentary (such as those in the classic subliminal priming studies), the attractor network fails to reconcile (and hence fails to produce conscious experience) due to insufficient input (Cleeremans et al*.,* 1998). Nevertheless, the mapping network can still affect the module's outputs (Cleeremans et al*.,* 1998).

Both the above approaches share some characteristics. Incidental learning includes a primary, highly sensitive recoding process connecting to the statistical features of a training set (Cleeremans et al., 1998). By using exemplars to produce and distribute knowledge, the nature of this learning is dynamic (Cleeremans et al*.,* 1998). In other words, learning is "incremental, continuous and best featured as a by-product of evolving processing" (Cleeremans et al*.,* 1998. p. 9). Particularly, incidental learning is said to be "unsupervised" and self-organised (Cleeremans et al*.,* 1998, p. 9). However, the determinants of such evolution are inconclusive to date.

A framework was suggested to classify computational theories of consciousness along two dimensions (Cleeremans & Jiménez, 2001). The first dimension, *process versus representation dimension*, proposed that a specific process may operate over a mental representation on one side of the scale compared with consciousness theories that classified inherent properties of mental representations (Cleeremans & Jiménez, 2001). On the other hand, a specialised versus non-specialised dimension contrasted consciousness models that shared similar properties for information-processing systems (Cleeremans & Jiménez, 2001). Specialised models, such as Privileged Role models, assumed that brain systems played a role in "subtending consciousness" (Cleeremans & Jiménez, 2001, p. 8). These models may follow either a vehicle or a process rule (Cleeremans & Jiménez, 2001). At the opposite end, non-specialised models, such as Quality of

Representation models and classic vehicle theories, recommended that the awareness of experience is the possession of the experience rather than the act itself (Cleeremans & Jiménez, 2001).

Some researchers are concerned about the limitations of computational modelling. One of the criticisms is that different computational systems may often turn out to be functionally equivalent even though they may be based on different processing principles (Cleeremans et al., 1998; Cleeremans & Jiménez, 2001). That is, one may behave in a rule-like manner without encoding the rules explicitly (Cleeremans et al., 1998; Cleeremans & Jiménez, 2001).

Other researchers claimed that computational modelling is not empirically differentiable (e.g., Cleeremans & Jiménez, 2001). This view suggested that the performance of symbolic systems based on chunking (e.g., Servan-Schreiber & Anderson, 1990) may overlap significantly with the performance of the *Simple Recurrent Network* (Servan-Schreiber et al., 1991) in artificial grammar learning tasks (e.g., Berry & Dienes, 1993). Likewise, Logan's (1988) instance-based model is said to coincide with *reinforcement-based connectionist model* (e.g., Barto et al., 1983) in the context of process control tasks, in terms of how well the models accounted for empirical data (e.g., Cleeremans & Jiménez, 2001). That is, it may dissipate to segregate experiences that continuously affect current and subsequent information processing (Cleeremans & Jiménez, 2001), in particular, implicit learning (Frensch & Rünger, 2003).

Although neurosciences, such as neuropsychological and neurophysiology studies, as well as neuro-imaging techniques, offer alternative approaches to these issues, on-going and inconclusive studies have been unable to decide the mechanism of implicit learning, especially in natural settings (e.g., Rose et al., 2002; Ashby & Casale, 2003; Schendan et al., 2003; Frank et al., 2006; Filoteo et al., 2010; Lane & Liang, 2010). Some researchers suggested a need to consider "evolutionary, developmental and information-processing" related factors in developing computational models of consciousness (Atkinson et al., 2000, p. 381).

The shift of the implicit learning paradigm, from a static property to a complex process reinforced by graded consciousness, enables an inclusive way to examine incidental learning in natural settings, such as a workplace. Moving from models of consciousness, the following section reviews literature related to adaptive learning and the learning environment. It explains how a task demand and a learning environment might reinforce one's adaptive learning behaviours and why the current study adopts a cross-disciplinary theoretical framework.

Adaptive Learning and Sensitivity Towards a Learning Experience

Many researchers have suggested that the excessively high and rigid standards for evidence of implicit learning, stemming primarily from the nature of laboratory experiments, have led to a conservative bias regarding the power of implicit processes (Cleeremans, 1997; Mathews, 1997; Lieberman, 2000; Cleeremans & Jiménez, 2001; Evans, 2003; Sun et al., 2005). Everyday situations tend to engender more flexible implicit learning; learning that is sensitive to environmental conditions (Lieberman, 2000; Kolb et al., 2000; Stanovich & West, 2000; Evans, 2003; Sun et al., 2005). Mathews (1997) proposed this view in his statement, below:

> *"Additional research that emphasises high levels of skills in control of complex systems may reveal greater adaptive power of implicit processes. Nevertheless, such research may require less methodological purity and more emphasis on synthesis of theoretical ideas rather than analysis into pure cases." (*p. 38)

If graded consciousness plays a role in implicit learning, then implicit learning might be adaptive. In other words, adaptive learning is a collection of "philogenetically advanced adaptation processes" (Cleeremans & Jiménez, 2001, p. 3). When one's sensitivity to an experience evolves, he or she may find it easier to control his or her action in a complicated, unfamiliar environment (Cleeremans & Jiménez, 2001). Some researchers who support this view claimed that implicit learning may form the basis of conscious experience by shaping both the subject's perception and internal representation of the world (Perruchet & Vinter, 1997; Block, 1995, 2005). In a natural setting, the implicit learning system may evolve according to the degree of sensitivity of one's learning experiences (Brézillon & Pomerol, 2001; Mathew et al., 2001; Schunk, 2008). These include, but are not limited to, the learning of language (e.g., Reber, 1967; Proulx & Heine, 2009), drawing (e.g., Vinter & Perruchet, 2000), visual spatial (e.g., Chun & Jiang, 1998; Hulstijn, 2002; Filoteo et al., 2010), musical structure (e.g., Tillmann et al., 2000), as well as emotional and social behaviour learning (e.g., Dolan, 2002; Bolte et al., 2003). Some researchers call this sensitivity "intuition" (Osbeck, 1999; Lieberman, 2000; Bolte et al., 2003). If the learning of task, emotional and social abilities in a polar environment is adaptive, one's exposure to a learning environment, task demand, awareness and intentionality of engaging in learning may form implicit learning mechanisms. The following section reviews these issues.

Environment Regularity, Awareness, Intention and Task Demands

Although implicit learning of tacit knowledge might be acquired, debatably, through 'non-consciousness' or 'consciousness', research suggests that the subjects have to be emotionally aroused (with a certain level of awareness) during different learning phases, in order for tacit knowledge to be acquired, realised, reflected, transferred and applied (Dienes & Altmann, 1997; Eraut, 2000, 2004; Fredrickson, 2001, 2004; Bolte et al., 2003; Simons & Ruijters, 2004). Subsequently, tacit knowledge may surface (i.e., retrieval) and be applied explicitly (i.e., explicit application) through reflection if the degree of awareness increases. Hence, it becomes expressible and assessable (Gramaldi & Torrisi, 2001; Hedlund et al., 2002, Høyrup, 2005; Robertson et al., 2005; Eitam et al., 2008). Some researchers named this process self-initiated rehearsal (Marsch et al., 2006).

Frensch and Rünger (2003) proposed a model to show five possible relationships between learning and the awareness of what was learned. Instead of a pure process, his model suggested implicit learning may interact with non-implicit learning in different phases of the learning process to form tacit knowledge (Frensch & Rünger, 2003). For the purpose of this thesis, only those approaches dealing with implicit learning are shown in Figure 3, below. Some researchers suggested that implicit learning research should focus not only on awareness, but on other criteria, such as the role of intention during the learning and the comparison between task demands during learning and subsequent use of that knowledge (Whittelsea & Dorken, 1997; Cleeremans et al., 1998; Marsch et al., 2006).

Most research investigated the difference between implicit learning and non-implicit learning to demonstrate the absence of learners' awareness of the acquired knowledge, yet they appeared to overlook at least two aspects of implicit learning (Block, 1995, 1999, 2005; Frensch & Rünger, 2003). As demonstrated in Frensch & Rünger's model (2003) below, an individual may take different paths to learn implicitly in natural settings. The majority of implicit learning models failed to demonstrate which learning route(s) an individual may take and at which stage of learning, in time, when the person reported about his or her learning experiences. These models also fall short in demonstrating the multifaceted nature of consciousness at different learning stages, especially where a complex task may demand complicated, dynamic skill learning (Evans, 2003; Sun et al., 2005). Apart from the above challenges, individual differences, perceived learning environmental regularity, and graded awareness of learned behaviours may also affect the study of implicit

learning in natural settings (Block, 1995, 1999, 2005; Shinoda et al., 2001; Frensch & Rünger, 2003; Robertson et al., 2005; Shanks, 2005; Marsch et al., 2006).

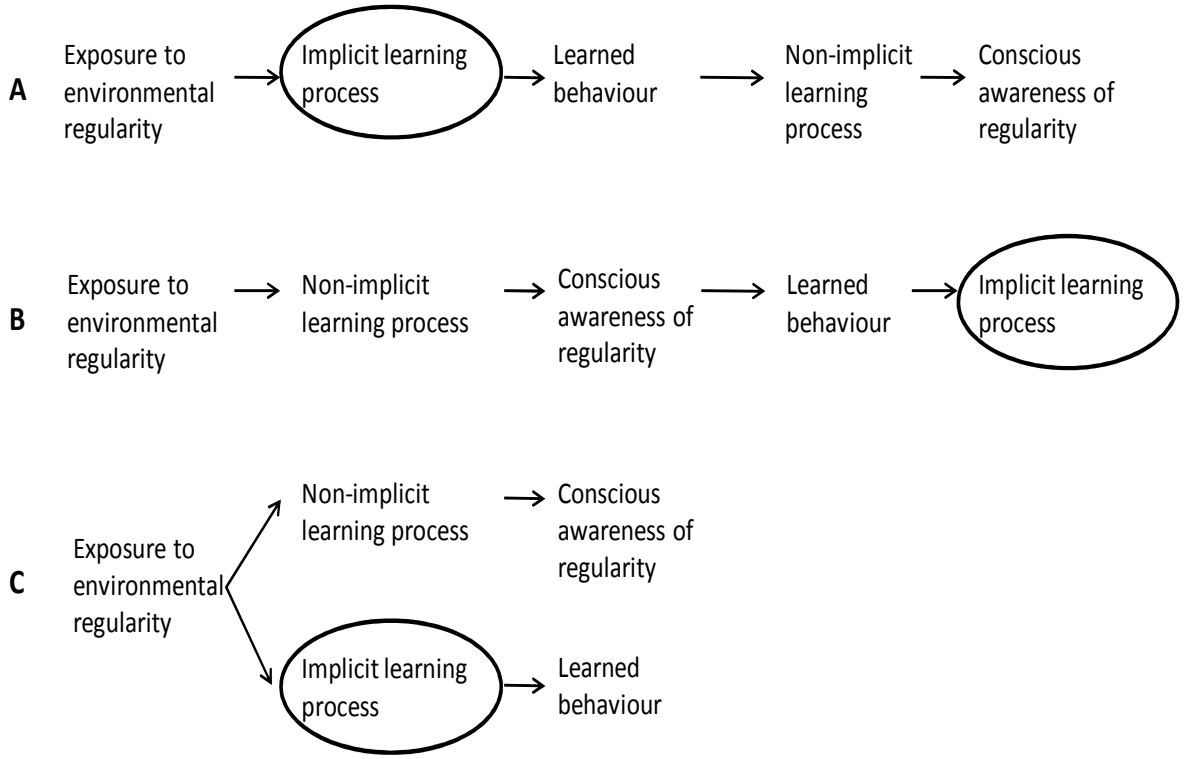

Figure 3: Possible Relationships
Between Implicit Learning and Awareness of a Learning Experience

Adapted from: Frensch & Rünger (2003)

The empirical studies, methodological and theoretical issues discussed in this section indicate a need to look at implicit learning from a macroscopic perspective, for the purpose of the current study, as summed up by Gaillard, Vandenberghe, Destrebecqz and Cleeremans (2006):

> *"Implicit learning offers a rich domain through which to pursue these explorations for it doesn't coerce us into reducing consciousness to a static, dichotomous property associated with some mental states and not with others, but instead makes it possible to approach it as what it is: a complex, multifaceted phenomenon."* (p. 15).

1.4 Research Settings: Polar Workplace

By examining the research settings, this section seeks to provide an overview of the nature of polar workplace that contributes to social-psychological adaptation issues to be discussed in the next section.

1.4.1 Historical Development of the Polar Workplace

Isolated for 140 million years and not fully mapped until the 1950s, Antarctica is the coldest, driest, windiest and most isolated continent, formed 98% by ice (Harrowfield, 2007). General coastal types around Antarctica include ice shelves or floating ice, ice walls that rest on the ground, ice streams or outlet glaciers, and rock (https://www.cia.gov/library/publications/the-world-factbook/geos/ay.html). Inland the landscape ranges from frozen desert to ice-free region, such as McMurdo Dry Valley (Hince, 2000; Harrowfield, 2007). East Antarctica is colder than West Antarctica because of its higher altitude (http://www.antarctica.ac.uk).

Although human adaptation issues in Antarctica were recorded as early as the 1800s in the personal diaries of polar explorers, the importance of human social-psychological and crew selection criteria came under the spotlight in the 1900s (Harrison et al., 1990). Typical polar work conditions in the early 1900s were captured by Sir Ernest Henry Shackleton's newspaper advertisement: "Men wanted for hazardous journey. Small wage, bitter cold, long months of complete darkness, constant…Safe return doubtful…and recognition in case of success." (Watkins, 1959, p. 1). Nonetheless, approximately 5000 applicants applied for 28 job vacancies for that deployment (Taylor, 1987).

Human adaptation and crew selection have certainly attracted much attention since the International Geophysical Year (IGY) 1957-1958 (Taylor, 1987). Due to recognition of the potential contribution of Antarctica to natural science, resources and political tension, the Antarctic Treaty System (ATS) was established in 1961 to prohibit military activities and mineral mining, support scientific research and protect the ecozone between 60 and 90 degrees of latitude South (http://www.ats.aq). Its members increased from 12 countries in 1959 to 48 countries to date (http://www.ats.aq).

In addition to research vessels, 64 research stations and facilities operate in the Antarctic Treaty Area (ATA) during summer and/or winter to date (www.comnap.aq). Twenty nine National Antarctic programmes were set up to manage and support increasing scientific projects, research stations and facilities, field sites and vessels to date (Fogg, 2007; www.comnap.aq). Apart from

flourishing tourism in Antarctica, the majority of the personnel who go south are scientists and support personnel (www.comnap.aq). Approximately 60 countries are involved in scientific research during the International Polar Year (IPY) 2007-2008 (http://ipy-osc.no/).

Over the past 50 years, the use of civilian, instead of military, support personnel in some national Antarctic programmes and the advancement of technologies, such as communication, transport and human resource expertise, has increased (Nelson, 1968; Gunderson, 1973; Owen, 1975; Taylor, 1987; Hanson, 1992, 2000; Gunderson & Palinkas, 1998; Rothblum, 2001; Grant et al., 2007; www.comnap.aq). This study focuses on polar personnel who have been deployed by different New Zealand Antarctic programmes since 1970.

1.4.2 Polar Personnel in New Zealand

Antarctic-related organisations in New Zealand can be classified into non-private and private sectors. These include government agencies, crown entities, non-governmental agencies, and business interests such as tourism operators and commercial fishing companies (see Figure 2).

Apart from the Environmental Assessment and Review Panel that was disestablished and reassigned to Antarctic New Zealand, the roles of other organisations have remained the same for several years (D. Martin, personal communication, February 17, 2010). At an operational level, internal business environmental factors, such as organisational and individual factors, seem to affect the work nature of polar personnel (M. Lindroos, personal communication, January 16, 2008; Antarctic New Zealand, 2008c). On a large scale, external business environment factors and the relationships of these Antarctic organisations may also influence the practice of polar deployment (http://www.antarcticanz.govt.nz/science/science-strategy). In particular, political, scientific, environmental and economic developments shape the funding for polar research, as well as the nature of polar work and selection of personnel for polar deployment (http://www.antarcticanz.govt.nz/science/science-strategy).

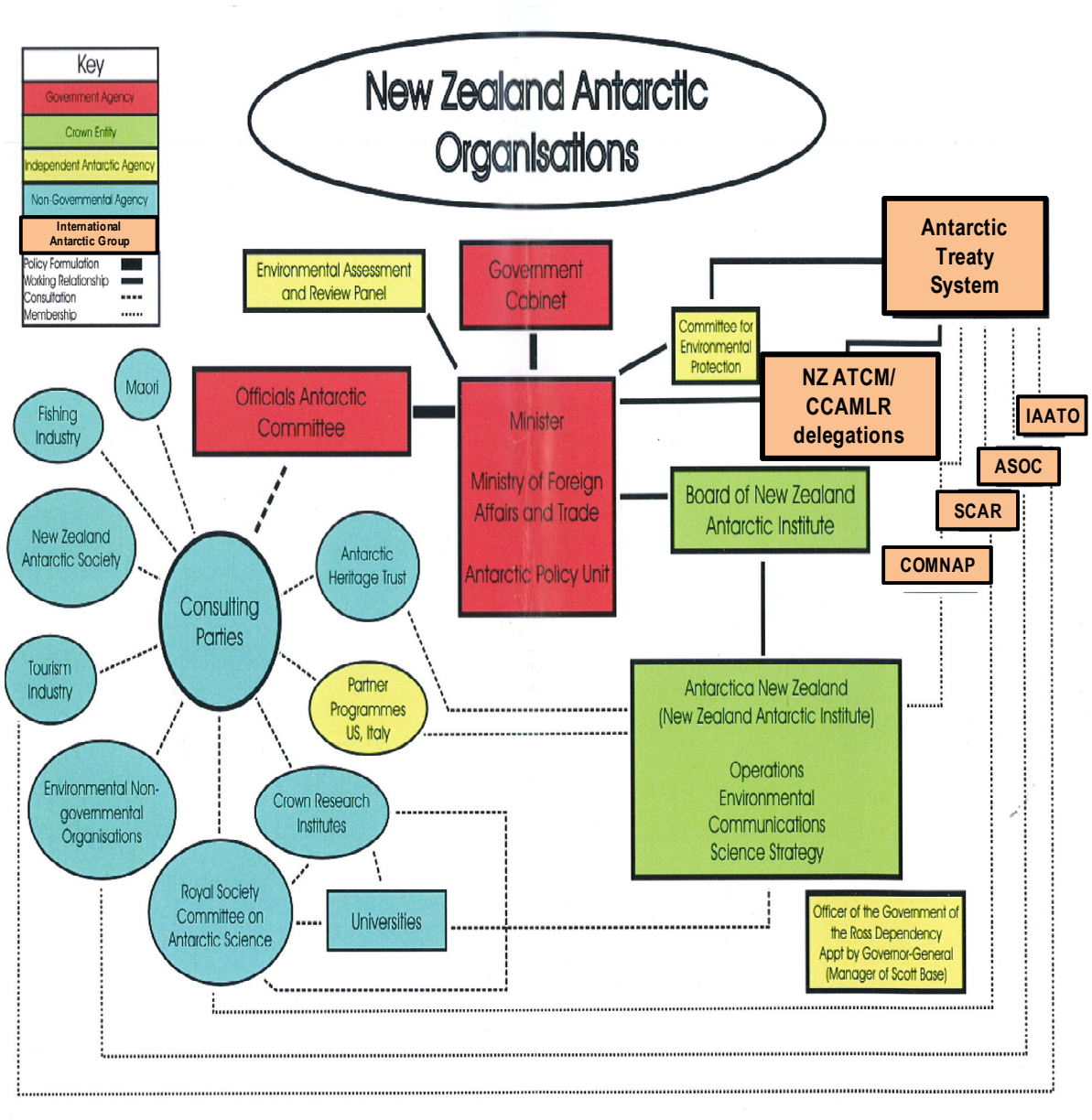

Figure 4: Types of Antarctic Organisations in New Zealand

Notes:

NZ ATCM	New Zealand Antarctic Treaty Consultative Meeting (http://www.ats.aq)
NZ CCAMLR	New Zealand Commission for the Conservation of Antarctic Marine Living Resources (http://www.ccamlr.org/)
IAATO	International Association of Antarctica Tour Operators (http://iaato.org/)
ASOC	Antarctic and Southern Ocean Coalition (http://www.asoc.org/)
SCAR	Scientific Committee on Antarctic Research (http://www.scar.org/)
COMNAP	Council of Managers of National Antarctic Programs (https://www.comnap.aq/)

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Martin, D. (2003). *We run the ice': a critical geopolitical gaze on New Zealand's relationship with the Ross Sea region, Antarctica*. Unpublished masters thesis, University of Canterbury, New Zealand.

Depending on the nature of their employment, polar personnel in New Zealand Antarctic programmes divide into four major groups (see Table 1, below). These workforces differ in terms of their work habitat, such as work nature, workplace, length of stay and work relationships with others during their deployment. Apart from Antarctica New Zealand, the use of psychological assessment for formal selection of polar personnel does not appear to be a common practice in Antarctic-related organisations in New Zealand (Antarctic New Zealand, 2008c; Tan & Steel, 2008).

Table 1: Categories of Polar Personnel in New Zealand

Category	Description
Group 1	Scott Base specialist team deployed by Antarctica New Zealand
Group 2	New Zealand Defence Force personnel
Group 3	Science support and tradesmen deployed by non-Antarctica New Zealand organisations (e.g., science technicians for special projects)
Group 4	Scientists deployed by non-Antarctica New Zealand

Sources: Antarctic New Zealand (2008c); Tan & Steel (2008)

1.4.3 Polar Habitats and Workplaces

Polar workplaces, such as research stations, weather stations, field sites and research vessels, are unique habitats that bear some psychological resemblance to space stations and other capsule environments (Suedfeld & Steel, 2000; Harrison, 2005). Polar personnel work and live in isolated and confined extreme conditions, characterised by thin boundaries between work and personal life, limited resources, remoteness and unusual weather conditions (Suedfeld & Steel, 2000; Rothblum, 2001; Palinkas, 2003; Sandal et al., 2007). The composition of crew(s) and obtainable resources in research stations, field sites or vessels may vary. A typical polar population may range from two in the field to approximately 1000 residents at one time in McMurdo Station - the biggest American research station in Antarctica (https://www.comnap.aq/facilities). The general absence of a 24-hour day/night cycle leads to a need to work and live in total darkness or in complete daylight for most of the year. These workplace characteristics may influence the well-being of polar personnel biologically, socially and psychologically.

For the purpose of this study, the term 'polar environments' is defined as a combination of the physical, organisational and social-cultural elements that form the working and living habitats in Antarctica and polar waters. The following sections describe the physical features of the natural and constructed environments and their implications for human activities in polar regions.

Natural Environment and Human Activities

Antarctica is characterised by two polar seasons: summer (December to February) and winter (March to November) (http://www.antarctica.ac.uk), although there can be significant transitional seasons between these periods, depending on the latitude of the station or field camp. Summer is characterised by 24 hours of sunlight, winter by 24 hours of darkness. During the summer, snow surface reflects almost 75% of the ultraviolet light falling on it, resulting in common health issues, such as sunburn and, more occasionally, snow blindness (Hince, 2000; http://www.antarctica.ac.uk). The mean temperature during the summer is close to freezing, with the highest temperature recorded thus far being 14.6°C in Hope Bay and Vanda Station on January 5, 1974 (http://www.ncdc.noaa.gov/oa/climate/globalextremes.html). The average temperature in the Antarctic Peninsula is warmer than other parts of Antarctica (http://www.antarctica.ac.uk).

Severe low temperatures in Antarctica vary by latitude, altitude and distance from the sea (http://www.ncdc.noaa.gov/oa/climate/globalextremes.html). During the winter, the outdoor temperature may go below -60 °C (http://www.antarctica.ac.uk). The coldest ever recorded was −89.2 °C at the Russian Vostok Station on July 21, 1983 (http://www.ncdc.noaa.gov/oa/climate/globalextremes.html). The sun crosses the equator towards the southern hemisphere and marks the end of the southern winter in September (Hince, 2000; Harrowfield, 2007).

Natural hazards, such as crevasses, katabatic winds, whiteouts and blizzards, are some conditions that may affect and restrict human activities in the polar environments (Hince, 2000; Harrowfield, 2007; Antarctica New Zealand, 2007a, 2008a). According to the field manual of Antarctica New Zealand (2007a), three levels of weather conditions are used as a general safety guideline for human activities in the polar environments. These conditions are categorised by levels of visibility, sustained wind speed, wind chill and the risk of getting frostbite when human skin is exposed to the conditions. The following descriptions of these conditions are based on the 2007 Antarctica New Zealand field manual; the direct quotations can be found in that publication on page 19.

Condition 1 (“Danger”) is characterised by “visibility less than 30 metres...sustained winds over 100 km/h (55 knots)...wind chill lower than -73 °C...[and] high risk of frostbite for most people in two minutes exposure or less”. Under this condition, individuals are not permitted to travel by vehicles. Individuals need to obtain the approval from Scott Base Manager or Programme Support Manager in order to travel outside by foot. Permission may be granted only to defined area around the base.

Condition 2 (caution condition), is defined by “visibility less than 300 metres...sustained winds [between] 89-100 km/h (48-55 knots)...wind chill [from] -60°C to -73 °C…high risk of frostbite...in two to 30 minutes exposure”. In this condition, permission to use vehicle and travel outside by foot is within the discretion of Scott Base Manager or Programme Support Manager.

Lastly, Condition 3 (normal condition) is featured by “severe weather possible within 24-48 hours...low risk to...frostbite with less than 20 minutes exposure”. Standard Antarctic precautions for travelling will be used as a guideline under this condition.

Although summer temperatures are usually more settled compared with the winter, prevention and precautions for individual and group health, safety and environmental concerns are always major issues for management, the scientists and support personnel when carrying out their missions (Antarctica New Zealand, 2007a, 2008a; http://www.antarcticanz.govt.nz).

Mental health and physical fitness are, therefore, required of polar personnel before their deployment. Information about the preparation and operation of polar deployment is available on the website of Antarctica New Zealand (http://www.antarcticanz.govt.nz). For example, in order to equip polar personnel for polar deployment, Antarctic New Zealand provides first aid and safety training to Scott Base support personnel before their deployment. Upon arrival at Scott Base, polar personnel go through briefings and Antarctic Field Training in order to learn the essential survival skills in this environment. These skills include snow craft skills, recognition of the dangers of the unique Antarctic environment, knowledge of safety routines and techniques (e.g., radio communications), ability to make shelter and cooking of food in emergency situations, information about sea ice processes and danger points, as well as techniques and procedures to set up and manage a field camp. In order to ensure the safety of polar personnel and facilities, some Scott Base and McMurdo personnel work together in a Search and Rescue (SAR) team.

Constructed Environments

In view of the natural environment, constructed environments are designed to accommodate human activities in these hostile conditions. In general, constructed environments divide into research stations, weather stations, field sites and research vessels (see Photos 1, 2 and 3, below). These environments vary in terms of the degree of remoteness, such as their facilities, resources, support, safety and capacity of population (http://www.niwa.co.nz/our-services/vessels; http://www.antarcticanz.govt.nz; Antarctica New Zealand, 2007a, 2008b).

Photo 1:
Research Station
- Scott Base

Steel (2010)

Photo 2:
Field Site in Antarctica

Respondent S18

Photo 3:
Research Vessel
in Polar Waters

Respondent S13

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The following sections provide a general portrait of some of these polar environments, including Scott Base, the New Zealand research station, where most of the support personnel in this study spent their time during their deployment.

Research Station: Scott Base

Named after Sir James Clark Ross, who led the first expedition to the Ross Sea, in January, 1843, the Ross Dependency was claimed by Britain. It was later put under the care of New Zealand, on July 30, 1923 (http://www.antarcticanz.govt.nz). Scott Base, named after Captain Robert Falcon Scott (1868-1912), was built at Pram Point (77°51.00'S, 166°45.77'E) initially to support the British Trans-Antarctic Expedition (TAE) and science activities related to the International Geophysical Year (IGY; 1957-1958) (http://www.antarcticanz.govt.nz).

Scott Base became a permanent base in 1962 (http://www.scottbase50years.co.nz). It was placed under the care of Department of Scientific and Industrial Research (DSIR) and managed by

the New Zealand Antarctic Programme (Antarctica New Zealand, 2007b). This responsibility was transferred to the Ministry of Foreign Affairs and Trade in 1992 (Antarctica New Zealand, 2007b). Through the New Zealand Antarctic Institute Act (1996), the New Zealand Antarctic Institute (commonly known as Antarctica New Zealand) was set up on July 1, 1996, to develop, manage and support New Zealand's activities in Antarctica and the Southern Ocean (http://www.antarcticanz.govt.nz/about-antarctica-nz/key-activities). The missions of Antarctic New Zealand are to develop and support science at the domestic and international level, protect environmental values, deliver information services, guide tourist and commercial activities, and coordinate logistical support (http://www.antarcticanz.govt.nz).

Today, Scott Base is a year-round research station that accommodates a population that ranges from 10 in winter (October to October) to 85 during summer (October to February) (Harrowfield, 2007; http://www.antarcticanz.govt.nz). Apart from other international collaboration, major science projects currently supported by Antarctic New Zealand include Antarctic Physical Environments Research, Southern Ocean Research, and Antarctic Ecosystems Research with a focus on global warming (http://www.antarcticanz.govt.nz). Scott Base also supports non-science projects, such as education outreach, artists, media and youth programmes and visitors, as well as the recent Ross Island Wind Energy project (http://www.antarcticanz.govt.nz).

Modern facilities and support provided at Scott Base, such as the transportation, communication, formal training and monitoring procedures, appear to be more structured and sophisticated than the systems between 1960 and 2000 (Harrowfield, 2007; http://www.antarcticanz.govt.nz). Due to improvements in transportation and communication, it can be easily argued that the degree of remoteness at the station has been reduced over the years. As meals are provided by professional chefs to the occupants, work and social routines at the station seem to be relatively more structured and physically comfortable compared with those in the field (http://www.antarcticanz.govt.nz).

Although Scott Base was the main context for the research, experiences in other research stations were also mentioned by participants in this study. These stations include McMurdo and Amundsen-Scott (United States of America), Cape Hallett, Signy and South Georgia (United Kingdom), Marambio (Argentina), Vanda (a former New Zealand station), and other smaller, more remote weather stations. The specific details of the major stations are accessible in the official websites of these national Antarctic programmes and the Council of Managers of National Antarctic Programs (COMNAP) (www.comnap.aq).

Field Sites

The current study classifies field sites into deep field and normal field (based on geographic location). These range from small to large, based on crew population. Apart from geographic location, field sites also differ by the availability of facilities, resources, support, as well as the safety and capacity of the population (Harrowfield, 2007). Deep field refers to the locality where activities are carried out at 185 km or more from Scott Base (Harrowfield, 2007). These latter places are beyond the reach of common, land-based transportation, so helicopters or vessels are the usual deployment and re-supply vehicles.

Research Vessels

Both the scientists and science support personnel may carry out marine-related research, such as oceanographic, fisheries and coastal research, as well as marine engineering and environmental studies on a research vessel during summer (http://www.niwa.co.nz/). To date, the major operators in New Zealand are the National Institute of Water and Atmospheric Research (NIWA) Vessel Management Ltd and those from the fisheries industry (http://www.niwa.co.nz/).

Given the challenges associated with working and living in I.C.E. environments (Palinkas, 2000, 2002, 2003; Suedfeld & Steel, 2000; Steel, 2000), and the inherent need to rely on one another for support, it is perhaps not surprising that, amongst the polar personnel, there is "a special relationship with each other and with the landscape" (Crossley, 1995, p. 7).

As the deployment selection, support and training provided to polar personnel may differ from one organisation to another, the range of tacit knowledge needed and learning-related issues may vary in according to the demands for human activities in these environments.

1.5 Social-Psychological Adaptation in Polar Environments

In view of the importance of polar deployment, this section reviews the human/social science research in polar literature, particularly from the aspect of social-psychological adaptation. The social-psychological adaptation issues in polar environments and their implications for incidental learning of tacit knowledge demonstrate that polar psychology has conventionally investigated social-psychological adaptation and polar selection from environmental, social and personality perspectives (e.g., Harrison et al., 1990; Ursin et al., 1991; Harrison, 2005; Steel et al., 1997; Dudley-Rowley, 1999; Lugg & Shepanek, 1999; Suedfeld & Steel, 2000; Suedfeld & Weiss, 2000a, 2000b; Palinkas, 2001a; Palinkas et al., 2001; Suedfeld & Weiszbeck, 2004; Lugg, 2005; Nolan, 2005; Tafforin, 2005; Sandal et al., 2007). Although polar abilities are generally regarded as

critical for polar adaptation (see, e.g., Gunderson, 1973; Taylor, 1985, 1987; 2002; Steel et al., 1997; Palinkas, 2003), to date, no study has yet investigated how an individual learns these types of tacit knowledge in the polar workplace.

As one of the space analogues on Earth, Antarctica offers a setting for the investigation of human physiological and psychological challenges in extreme environments (Harrison et al., 1990; Ursin et al., 1991; Taylor, 1998; Dudley-Rowley, 1999; Lugg & Shepanek, 1999; Suedfeld & Steel, 2000; Suedfeld & Weiss, 2000b; Palinkas et al., 2001; Rothblum, 2001; Suedfeld & Weiszbeck, 2004; Harrison, 2005; Lugg, 2005; Nolan, 2005; Tafforin, 2005; Sandal et al., 2007). According to a review of polar literature since the 1950s, human/social science research in polar environments focused on six major areas, as below:

- Health, safety and environmental aspects (e.g., Irving, 1974; Taylor & Frazer, 1981; A. Barabasz & M. Barabasz, 1986; Suedfeld, 1998; Palinkas & Houseal, 2000; Steel, 2000; Peri et al., 2000; Rosnet et al., 2000; Olson, 2002; Palinkas et al., 2005, 2010);
- Personality, selection and human performance (e.g., Owen, 1975; Taylor, 1985; Steel et al., 1997; Dudley-Rowley, 1999; Sarris, 2006; Grant et al., 2007; John Paul et al., 2010);
- Social-psychological adaptation, such as crew composition, social networks, small group dynamics, self-image and identity (e.g., Taylor, 1987; Rosnet et al., 2000; Steel, 2001, 2005; Weiss & Gaud, 2004; Décamps & Rosnet, 2005);
- Support needs, such as human, logistic, life and real-time support; crew member and crew-ground interactions; abort and fast return capability (pre-, during and post-deployment training) (e.g., Dudley-Rowley et al., 2001; Palinkas et al., 2004; L. L. Schmidt et al., 2005; Sarris & Kirby, 2007);
- Design, facilities and support technology (e.g., Carrere & Evans, 1994; Sundstrom et al., 1996; Dudley-Rowley et al., 2001, 2002; Yan & England, 2001; Ohno et al., 2010); and
- Applications of Antarctic human/social science for prolonged missions to other similar settings such as inner/outer space, capsule environments, isolated field and weather stations, submarines and offshore drilling rigs (e.g, Harrison et al., 1990; Ursin et al., 1991; Taylor, 1998; Dudley-Rowley, 1999; Lugg & Shepanek, 1999; Suedfeld & Steel, 2000; Suedfeld & Weiss, 2000b; Palinkas, 2001b; Palinkas et al., 2001; Suedfeld & Weiszbeck, 2004; Harrison, 2005; Lugg, 2005; Nolan, 2005; Tafforin, 2005; Sandal et al., 2007).

These adaptation challenges took place pre-, during (i.e., travelling to, or on-site), or after a deployment. Research in these areas conventionally employed the approaches of clinical, environmental, behavioural and social psychology. In New Zealand, apart from the database of Antarctica New Zealand by a private investigator (http://www.antarcticanz.govt.nz/k073-sleep-and-physical-activity-patterns-in-a-polar-environment), there is a lack of up-to-date literature on polar deployment in New Zealand.

The following sections provide an overview of these adaptation challenges. Although it is beyond the scope of this research to discuss each factor in detail, these issues highlight the demands of tacit knowledge for polar adaptation.

Pre-deployment

Selection for Deployment: Psychological, Medical and Intellectual "Fitness"

Due to high risks, physical and psychological challenges, and the cost of operating in Antarctica (Burns & Sullivan, 2000; Taylor 2002), the selection of personnel is critical for the success of polar deployment (Grant et al., 2007). Medical fitness is one common selection criterion (Barabasz, 1981). Explicit intellectual assessment is not commonly found in Antarctic-related organisations, including national Antarctic programmes (Hanson, 1992, 2000). Psychiatric criteria are usually used for 'selecting out' individuals with psychiatric disorders, whereas psychological criteria are usually used for 'selecting in', in order to predict human adaptation and performance in these environments (Grant et al., 2007). Apart from national Antarctic programmes, formal psychological assessment does not appear to be a common selection practice in other Antarctic-related organisations or activities.

The use of psychological assessment for selection is an unresolved issue in different national Antarctic programmes (Musson et al., 2002; Olson, 2002; Grant et al., 2007). National Antarctic programmes from the United States of America, Canada, Chile, France, New Zealand and Australia use a psychological test battery for selection especially for the wintering crews, whereas the selection panel from the United Kingdom chose to do without it (Olson, 2002; Grant et al., 2007; Tan & Steel, 2008). Common personality measures used in national Antarctic programmes, such as NEO Personality Inventory (Costa & McCrae, 1992, 2008), tend to be based on the "Big Five" personality traits (see, e.g., Steel et al., 1997; Musson et al., 2002; Grant et al., 2007). The absence of standard criteria and a lack of research opportunities for assessing polar personnel

across national and non-national Antarctic programmes make it difficult for a meta-analysis to evaluate the predictive utility of personality measures in these regions. Nevertheless, the use of the psychological inventory in the selection methods appears to increase the chance of identifying good performance and reduce the chance of selecting poor performers (Grant et al., 2007). Although no polar literature has looked into the relationship between personality and informal workplace learning, further review of personality and learning literature suggests that personality may affect individual learning in workplaces (Naquin & Holton, 2002).

Human Factors Engineering, Polar Workplace Learning and Gaps in the Literature

Natural and constructed environments may function as a learning environment for the study of workplace learning (Illeris, 2004). This section reviews the use of the human factors engineering approach to examine the adaptation and learning challenges faced by polar personnel in the polar workplace. It highlights a lack of these research areas in polar literature.

Apart from the perspective of environmental psychology (Sundstrom et al., 1996; Suedfeld, 1987, 1998; Suedfeld & Steel, 2000), human factors engineering (or ergonomics) offers a way to improve human performance through designing and engineering tools and environments, in order to meet the needs of the human users in remote worksites, such as the polar regions (e.g., Yan & England, 2001) and space exploration (e.g., Harrison, 2005; Suedfeld, 2010). This includes the study of personnel selection, training, structuring of situations and the process of organising, allocating, and measuring the process to carry out a task (Harrison, 2005). This approach involves the interdisciplinary understanding of human physical and cognitive abilities (Harrison, 2005). The first discipline involves anatomy, physiology and biomechanics (Harrison, 2005). The second discipline includes vision, audition, memory, retrieval and problem-solving, from the perspectives of biology, engineering and cognitive science (Harrison, 2005).

Compared with space psychology, human factors engineering does not seem to be a commonly researched approach employed in polar literature, even though polar personnel may have to handle, individually, a wide range of job- and non-job-related challenges, such as emotional and safety management under time-pressure (e.g., Dudley-Rowley et al., 2001). These challenges include ill-fitting habitats, poorly designed equipment, facilities and polar clothing, marginal life support systems, inadequate use of space and faulty communication (e.g., Dudley-Rowley et al., 2001; Harrison, 2005; Ohno et al., 2010).

Although it is important to understand the effectiveness of formal learning (Kirkpatrick, 1998; Arthurs & Bennett, 2003; Noe 2009) as to how training programmes conducted in Antarctic might affect the adaptation of the polar crews during their missions, there has been no published research in this area. Likewise, no literature about incidental learning is found in polar literature. This suggests a lack of support, either tangible or otherwise, for social science in this area.

During Deployment

When one takes into account the features of the extreme and unusual environment of the polar region (Suedfeld, 1987), the study of social-psychological adaptation in Antarctica divides into individual, organisational, and interpersonal issues.

Individual Issues

Physiological and Psychological Adaptation and Stages. The adaptation patterns amongst wintering crews in Antarctica cover four stages (e.g., Gunderson & Palinkas, 1998; Suedfeld, 1998; Taylor, 1998; Palinkas & Houseal, 2000; Peri et al., 2000; Weiss et al., 2000b; Steel, 2001, 2005; Décamps & Rosnet, 2005). During the first stage, crews attempt to adapt to the physical environment, workload and routine of work and life. The second stage begins when the crews have started to adapt to the new living condition, but have yet to experience the full range of physiological and psychological impacts of I.C.E. environments.

In the third stage, the crews may come up against stressors related to low stimulation (e.g., social monotony and boredom), a reduced social network, and, in the case of the polar regions, bitter cold and extended darkness. Symptoms at this stage may include emotional instability, hypersensitivity, depressive reactions and decline in motivation and energy. Medical issues reported consist of the effects of cold physiology, endocrine variation (e.g., “polar T3 syndrome”), ultraviolet light, changes in immune function, chronobiology, microbiology, psychology, epidemiology and telemedicine (Olson, 2002; Ohno et al., 2010; Palinkas et al., 2010). Most, if not all, of these challenges can be overcome or reduced with appropriate countermeasures.

Shortly before the end of the mission and before their return to the ‘civilised world’, the crews may enter the last stage of adaptation where individuals may feel euphoria and uncertainty about post-deployment life. No publication to date has demonstrated how polar personnel may learn to change implicitly during these phases.

Polar Self-image. Research in this area suggests personality and self-image may affect, and be affected by, polar adaptation during deployment (Rosnet et al., 2000). Although the study of self-image appears to be common in non-polar settings (e.g., Spencer et al., 1998), no literature explains how an individual acquires tacit knowledge during the process of forming self-images and identities or how self-image might affect individual learning in a polar environment.

Psychiatric Disorders. The majority of polar literature presents stressors in the polar workplace (e.g., Godwin, 1998; Steel, 2005) and statistical facts about psychiatric disorders and post-traumatic stress disorder, as well as the importance of preventing and managing such phenomena (e.g., Suedfeld, 1987; Palinkas et al., 2001, 2005); in particular, through selection processes (Grant et al., 2007). However, no polar literature explains how such disorders might change from one psychological stage to another.

Psychological Support and Countermeasures. Research in this area reported psychological support and countermeasures provided by Antarctic programmes to polar personnel, in particular, support staff (e.g., Hanson, 1992, 2000; L. L. Schmidt et al., 2005). However, no paper looks into how an individual learns about one's own changing needs at different stages of polar adaptation.

Personality and Other Factors. Some researchers have studied physiological and psychological responses, such as personality (e.g., Law, 1960; Steel et al., 1997; Rosnet et al., 2000; Décamps & Rosnet, 2002; Musson et al., 2002; Sarris, 2006), place attachment (e.g., Steel, 2000; Tafforin, 2005), privacy and the use of work space (e.g., Weiss et al., 2007), as well as sleep patterns (e.g., Bhattacharyya et al., 2008) in Antarctica.

Organisational and Interpersonal Issues

Polar Missions. Research in this field suggests that polar personnel may experience competing priorities in carrying out their missions during a polar deployment (e.g., Dudley-Rowley, 1999). Nevertheless, no study explains how an individual learns to acquire tacit knowledge in order to cope with these needs.

Composition of Crew. Most polar literature focuses on the study of polar crew composition and the implications for group dynamics. This comprises, but is not limited to, the following:

> ***Crew Size and Temporal Factors.*** Studies in this area investigated the potential effects of crew size, duration of deployment, mission interval and cycle, as well as polar season on group dynamics (e.g., Dudley-Rowley, 1999; Dudley-Rowley et al., 2001). No

publication examined how an individual learns to acquire tacit knowledge in order to cope with his or her own needs at different stages of a deployment.

Homogeneous versus Heterogeneous Crews. Investigations in this area involve cultural factors associated with polar adaptation across nations (Palinkas, 2001a; Musson et al., 2002; Sarris, 2006). No publication, however, reviewed how an individual learns to adapt to different group conditions.

Gender Differences. Research in this area focuses on how male and female differ in their perceptions and adaptation to polar deployment (e.g., Leon & Sandal, 2003). No study looks into how sex may affect learning to adapt to polar regions.

Group Dynamics. The majority of research, to date, focused on group dynamics. These studies include group development, norms, dynamics, autonomy, roles, inter- versus intra-group, social and communication networks, leadership, decision-making, problem-solving, ground-crew interaction, support, group morale and cohesiveness, community mental health, performance and organisational cultures (e.g., Owen, 1975; Suedfeld, 1987; Dudley-Rowley, 1999; Nolan, 2005; L. L. Schmidt et al., 2005; Tafforin, 2005; Sarris & Kirby, 2007). No literature reviewed how an individual learns to adapt to these group dynamics.

Organisational Factors. Despite the fact that the polar workplace is shaped by organisational designs, a lack of research in firm or organisational factors in Antarctic psychology literature to date demonstrates limited understanding of how an organisational policy, system, structure and process in an Antarctic programme may affect polar adaptation during a deployment (Norris et al., 2010).

Post-deployment

Most polar literature appears to emphasise the first two stages of a polar deployment. Apart from specific instances of post-deployment effects (e.g., Barabasz, 1981; Taylor & Frazer, 1981; Palinkas et al., 2001; Taylor, 2002), in particular, those recorded by national Antarctic programmes, few publications investigated what happened to polar personnel after a deployment. Although national Antarctic programmes, the Standing Committee of Scientific Committee on Antarctic Research (SCAR), Antarctic Logistics and Operations (SCALOP) and Council of Managers of National Antarctic Programme (COMNAP) may have generated working papers for operational uses (e.g., Hanson, 1992, 2000), it is difficult to compare unpublished findings with the polar literature.

Summary

In a recent review of Antarctic psychology research, Norris, Paton and Ayton (2010) suggested research to date has yet to capture adjustment factors across the phases of a deployment. More critically for the study described in this thesis, no publication has investigated how the learning experiences of a deployment may affect individuals' learning before, during and after a deployment.

1.6 Tacit Knowledge in Conventional and Polar Workplaces: Task, Emotional and Social-Related Knowledge

Despite decades of investigation regarding tacit knowledge from various disciplinary perspectives, and certainly since Michael Polanyi (1958) who proposed that we "know more than we can tell" (Polanyi, 2009, p. 18), the learning of tacit knowledge stubbornly remains a 'black box' phenomenon. On-going debates about the nature of tacit knowledge make it difficult to settle on a definition for this term. Many of these disputes emanate from the complex and subjective nature of implicit learning (Dienes & Berry, 1997; Mathews, 1997; Cleeremans et al., 1998; Cleeremans & Jiménez, 2001; Zeidner et al., 2004; Gaillard et al., 2006). However, a relatively inclusive definition suggests that *tacit knowledge is a form of knowledge that is untaught, unexpressed, personal, and might follow different functional rules from non-implicit learning* (Mathews, 1997; Cleeremans et al., 1998; Cleeremans & Jiménez, 2001; Zeidner et al., 2004; Gaillard et al., 2006). This section reviews the definitions, characteristics and empirical studies of tacit knowledge in conventional and polar workplaces, namely, *polar abilities.*

Tacit knowledge is critical at the individual and organisational levels in a workplace. Practical problems in a workplace are often chaotic and poorly defined, related to everyday experience, of personal interest, and in need of multiple 'best fit' solutions and methods of selecting this 'best' solution (Hedlund et al., 2002; Neuweg, 2005). Types of tacit knowledge vary across organisations and professions (Sternberg & Horvath, 1999; Poell et al., 2004; Davenport, 2005). Managing tacit knowledge implies a need to understand the process of acquiring and utilising tacit knowledge, as well as the resources needed to capture this process (Nonaka & Toyama, 2003; Nonaka, 2005; Savitt, 2005). This involves the openness to innovative ideas that might derive from unconventional ways and may build on limited evidence (Savitt, 2005). As not all organisational cultures and systems are ready to nurture this intellectual capital (DeSimone & Harris, 1998; Noe, 2009), many innovations and solutions that are gained by individuals in the

operation of a firm might be wasted (Fenwick, 2003; Davenport, 2005; Savitt, 2005). Paradoxically, this capability, awareness and initiative to seek tacit knowledge is critical for the survival of any organisation, ranging from the early polar explorers to the workforce of contemporary organisations (Harrowfield, 1997; Sternberg & Horvath, 1999; Nonaka & Toyama, 2003; Davenport, 2005; Nonaka, 2005; Savitt, 2005; Werner & DeSimone, 2009).

In the context of a workplace, tacit knowledge refers to the knowledge that is "usually not openly expressed or taught" (Wagner & Sternberg, 1985, p. 536), yet it is essential to succeed in managing oneself, one's career and others (Wagner & Sternberg, 1985; Sternberg, 1995, 2003, 2005). Tacit knowledge about *managing self* refers to the knowledge about how to manage oneself on a daily basis in order to maximize one's productivity (Wagner & Sternberg, 1985; Sternberg, 1995, 2005). This includes the understanding of prioritising, efficient and effective ways to accomplish tasks and knowledge about how to motivate oneself to maximise accomplishment (Wagner & Sternberg, 1985; Sternberg, 1995, 2005). Tacit knowledge about *managing career* refers to the knowledge about how to establish, enhance and improve the reputation in one's career (Wagner & Sternberg, 1985; Sternberg, 1995, 2005). This form of knowledge includes how to find ways to improve one's work competencies and how to gain the respect and confidence of those who judge the work. The third tacit knowledge, *managing others,* includes the knowledge of managing subordinates and one's social relationships, for example, the knowledge to assign tasks according to individual's strengths and to minimise their weaknesses, to motivate others and to get along with them (Wagner & Sternberg, 1985; Sternberg, 1995, 2005).

Context-specific knowledge about what to do in given situation(s), tacit knowledge is directly relevant to an individual's goals (Hedlund et al., 2002). Through the process of adapting, shaping and selecting environment that best suits one's self, this "…practical intelligence as embodied in tacit knowledge increases with experience, but it is profiting from experience, rather than experience per se…." (Sternberg, 2003, p. 147).

On the other hand, the majority of polar research has focused on the outcomes of 'best-fit' to the habitat, such as job or non-job performance (e.g., Dudley-Rowley, 1999; John Paul et al., 2010) and personality (Law, 1960; Steel et al., 1997; Rosnet et al., 2000; Musson et al., 2002). The *three abilities* described by Gunderson (1973) and others (Taylor, 1987, 2002; Steel et al., 1997; Palinkas, 2003) in the polar literature appear to overlap with task, emotional and social-related knowledge in more conventional workplaces (e.g., Wagner & Sternberg, 1985; Sternberg, 1995, 2005) (see Table 2, below).

Table 2: Tacit Knowledge in Conventional and Polar Workplaces – Task, Emotional and Social-Related Knowledge

Tacit Knowledge (TK) in Mundane Workplace	Three Abilities in Polar Workplace
TK in managing career refers to the knowledge to establish, enhance and improve the reputation in one's career.	*Task ability,* in part, refers to "the ability and motivation to do one's job".
TK in managing self refers to knowledge about *self-regulation*, primarily in order to maximise one's productivity.	*Emotional stability* is, in part, about self-regulation. It refers to the ability to "moderate peaks and troughs in one's mood".
TK in managing others refers to the knowledge to manage one's social relationships.	*Social ability* refers to the ability to "motivate others and to get along with them".
Sources: Wagner & Sternberg (1985); Sternberg (1995, 2003, 2005)	Sources: Gunderson (1973); Taylor (1987, 2002); Steel et al .(1997, p. 3); Palinkas (2003)

Managing jobs refers to the knowledge associated with one's occupational competencies, which has clear links to *task ability*. This form of knowledge requires an individual to identify, develop and apply his or her knowledge, skills, abilities and attributes to perform tasks, duties and responsibilities at work (Wagner & Sternberg, 1985; Sternberg, 1995, 2003, 2005).

The second type, *managing self,* refers to the knowledge about *self-regulation*, primarily in order to maximise one's productivity (Wagner & Sternberg, 1985; Sternberg, 1995, 2003, 2005). This includes the ability to prioritise efficient and effective ways to accomplish tasks (Wagner & Sternberg, 1985; Sternberg, 1995, 2003, 2005). It includes the ability to introspect and manage one's moods in order to reinforce oneself to maximise accomplishment, search for self-fulfilment and resources needed to do so (Sternberg, 2003). Management of moods bears directly on *emotional stability*.

The last domain, *managing one's interpersonal relationships,* is related to *social ability,* in that it refers to motivating others and getting along with them. This latter aspect is particularly close to the definition of social ability provided by Steel et al. (1997), in which they emphasise the ability to "smoothly interact with other people" (p. 3).

More often than not, tacit knowledge is not formally learned, is unorganised and is relatively inaccessible to others (Wagner & Sternberg, 1985) and results from an individual's

subjective experience (Block, 1995, 1999, 2005; Dienes & Berry, 1997). Tacit knowledge is essential for the development of skills and competencies (Yang, 2003). Given the right conditions, application of this knowledge may lead to the development of related abilities, skills and competencies that exhibit in one's performance at a workplace (Yang, 2003; Werner & DeSimone, 2009; Noe, 2009). This indicates that one's capability to acquire and utilise tacit knowledge may affect his or her performance at work. Table 2, above, explicitly shows the parallels between the domains of tacit knowledge and the three abilities found to be predictive of adaptation in the polar workforce. Although the management of Antarctic programmes conventionally focused on task-related knowledge, emotional and social-related knowledge attracted much attention from medical personnel and polar psychologists.

Descriptive Knowledge and Procedural Knowledge

Polar literature primarily focuses on the *descriptive knowledge* (also called declarative or 'know what' knowledge) (Smith, 1994; Yang, 2003) associated with 'environment-people fit' issues. To date, no polar literature has investigated the processes through which an individual learns this *descriptive knowledge* and how such learning may initiate or reinforce one's ability to adapt across time; *procedural knowledge* or 'know-how' (Smith, 1994; Yang, 2003) is largely neglected. Both aspects of knowledge appear to encompass the study of the 'subjective world' rather than the 'objective world' of learning experiences (Brown, 1998). By examining one's own mental stages, an individual may identify his or her own mechanisms and strategies in order to meet learning needs. Such self-directed learning may affect one's wellbeing and performance at different phrases of a polar deployment.

Given the theoretical connections between the domains of tacit knowledge and polar abilities, the current study undertook the investigation of task, emotional and social-related knowledge from the perspectives of the polar personnel. Based on the definitions and approaches reviewed above, the current study adopts the following definitions in order to provide clarity for discussion:

- *Tacit knowledge* is a form of knowledge that is untaught, unexpressed and personal (Wagner & Sternberg, 1985; Sternberg, 1995, 2005).
- *Implicit learning* is a form of learning that is unintentional, contextualised, personal and highly dynamic (Cleeremans et al., 1998; Frensch & Rünger, 2003; Gaillard et al., 2006).

It is a self-organising and evolving learning process where awareness conveys the process - "a complex, multifaceted phenomenon that defies easy definition" (Gaillard et al., 2006, p.15).

1.7 Proposed Theoretical Framework

In view of gaps in the literature and methodological issues discussed above, the current study employs, as the research framework, an integrative learning model that comprises the three sub-models below:

- Informal Workplace Learning Model (see Figure 5)
- Adaptive Implicit Learning Model (see Figure 6)
- Learning related Emotional Effects from 'Novice' to 'Expert' (see Figure 7)

This theoretical framework provides general categories of factors that may contribute to learning behaviours in polar environments, such as the space, people, process and temporal factors associated with learning. The following sections explain these models and the rationales for adapting them for the current study.

1.7.1 Proposed Informal Workplace Learning Model for Polar Workplace

A review of psychology, social and management science literature suggests that workplace learning is an essential social transformation process in a particular context (Kirby et al., 2003; Zegwaard et al., 2003; Hodkinson et al., 2005). Thus, it is insufficient to study workplace learning from the science of 'mind' without taking into account the 'social world' where the learning takes place (Illeris, 2004; Hodkinson et al., 2005).

Adapted, in part, from the research by Illeris (2004), the current study proposes the Informal Workplace Learning Model (see Figure 5) as a theoretical framework to examine informal workplace learning in polar workplaces. With the recognition of the interplay between a context and a learner at a workplace (Illeris, 2004), this model suggests potential relationships among the physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments, as well as individual learning process (LP) at a polar workplace.

Apart from capturing the *social level* of the work environment where learning may take place, this model also suggests that this 'objective learning environment' is present in the subjective experience and perception of an individual (Jørgensen & Warring, 2001; Illeris, 2004).

These experiences and perceptions can be captured by the two other proposed models at an individual level: Adaptive Implicit Learning (see Figure 6) and Learning related Emotional Effects from 'Novice' to 'Expert' (see Figure 7). The following section discusses how the current study draws on these models as part of the theoretical framework for investigation.

Where the physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environment factors overlap, *work practice* appears to interact with *work identity* in order to reinforce workplace learning (Illeris, 2004). According to Illeris (2004), *work identity* is a psychosomatic concept that associates with the way in which a person sees himself, and how he notices the changes in himself when he is observed by others at a workplace. Subjective perceptions and actions taken by an individual may influence his or her own learning process at different stages of learning and via versa (Illeris, 2004). In turn, how an individual perceives his or her learning environment may affect his or her adaptation to the learning environment (Illeris, 2004). Given the unique nature of polar workplace, such as thin boundaries between work and personal life, the current study left the concept of *identity* open for investigation in order to explore different forms of identities, such as personal, social and polar identity, besides work identity in a polar workplace.

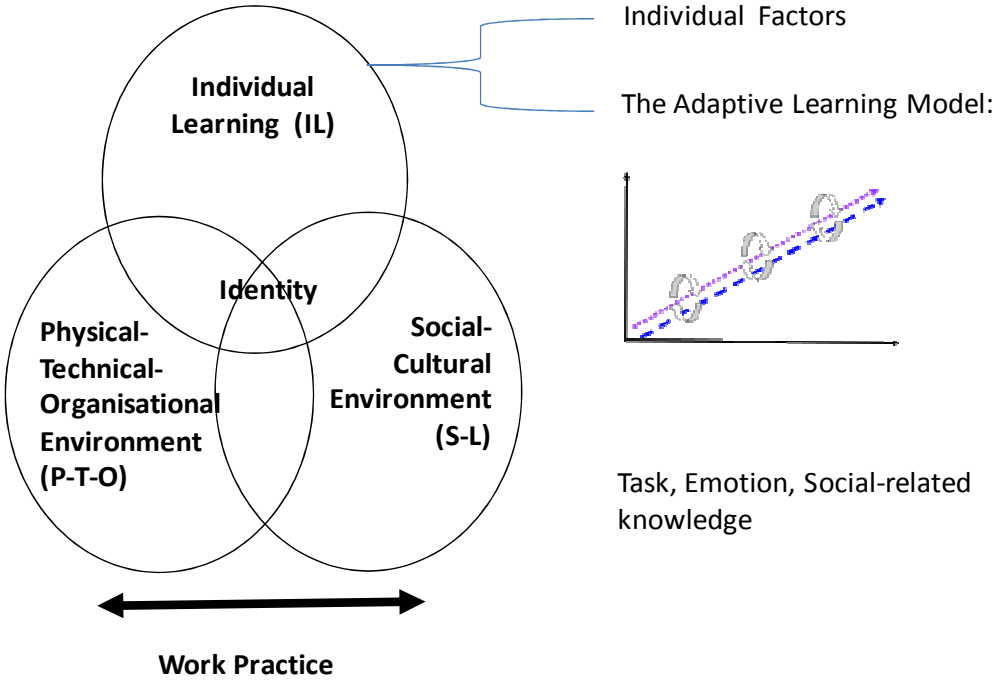


Figure 5: Proposed Informal Workplace Learning Model for a Polar Workplace

Adapted from: Illeris (2004)

Likewise, in order to avoid Type 1, 2 and 3 errors of the validity of qualitative research (Silverman, 1993, p. 149), the current study kept the rest of the factors in this model open for investigation.

The first major category, physical-technical-organisational (P-T-O) learning environment, consists of three subcategories. *Physical environment* factors refer to the natural and constructed environments where the respondents in the current study spent the most time working and living during their polar deployment. This category has been added to original model of Illeris (2004), based on the assumption that physical environment may play a more critical role in the polar workplace compared with more conventional workplaces. *Technical* factors refer to task demands; for instance, task, duties, responsibilities and abilities required for work and non-work related tasks during a polar deployment. Lastly, *organisational* factors represent the firm or organisational systems or structures that may comprise the division of work, work autonomy and work control associated with a polar deployment.

The second major category, social-cultural (S-C) learning environment, involves social and cultural issues related to incidental learning during a polar deployment. This category involves stressors and non-stressors related to polar crew composition, such as crew size, social norms and dynamics, as well as other social factors associated with polar summer and winter crews.

Lastly, individual learning (IL) covers any learning factors at an individual level. The first factor, *learning content* (LC) refers to the types of task, emotional and social knowledge that polar personnel might learn during a polar deployment. Secondly, *individual factors* (IF) deals with individuals' knowledge, skills, abilities and other attributes for managing task, emotional and social challenges during a polar deployment. These individual factors include the biographic factors associated with informal workplace learning, such as polar-related work experience, age, sex and personality. Lastly, *learning dynamic* (LD) refers to one's perceived exposure to a polar learning environment. This domain includes environmental regularity, learning stages, intention, awareness, reflection, emotion, barriers and demands related to the learning task, emotional and social knowledge in a polar environment (Gunderson, 1973; Taylor, 1985, 1987, 2002; Steel et al., 1997; Frensch & Rünger, 2003). These factors were investigated in the light of two learning-related models and concepts to be discussed in the following sections.

1.7.2 Proposed Adaptive Implicit Learning Model for People on Polar Deployment

Based on the discussion and the learning model proposed by Frensch & Rünger (2003) in Section 1.3.3 (see, also, Figure 3), the Adaptive Implicit Learning Model (see Figure 6) suggests a learning process may change, qualitatively, when an individual transforms from a novice to an expert (Eraut, 2000; Fredrickson, 2001, 2004; Simons & Ruijters, 2004). This model takes into consideration the learning content (LC), individual factors (IF) and learning dynamic (LD) proposed in the first model.

The Adaptive Implicit Learning Model (Figure 6) includes the following assumptions. Argyris and Schon's Theory of Action (1974) proposed human agents comprehend their environments and construct their actions accordingly in order to achieve an outcome. That is, an individual has to be aware of his own learning intentions (and hence is emotionally aroused by these intentions) to a certain extent, in order for knowledge to be acquired, reflected, transferred and applied during different learning phases. The degree of perceived exposure to a learning environment or event might provide the opportunity for tacit knowledge to surface and be explicitly applied (Frensch & Rünger. 2003). However, the degree of awareness towards what has been learned may depend on the presence of simple reflection or critical reflection, intention, as well as regularity of exposure to a learning environment and a task demand (Craik, 1967; Argyris & Schon, 1974; Greenwood, 1998; Gramaldi & Torrisi, 2001; Hedlund et al., 2002, Høyrup, 2005; Robertson et al., 2005).

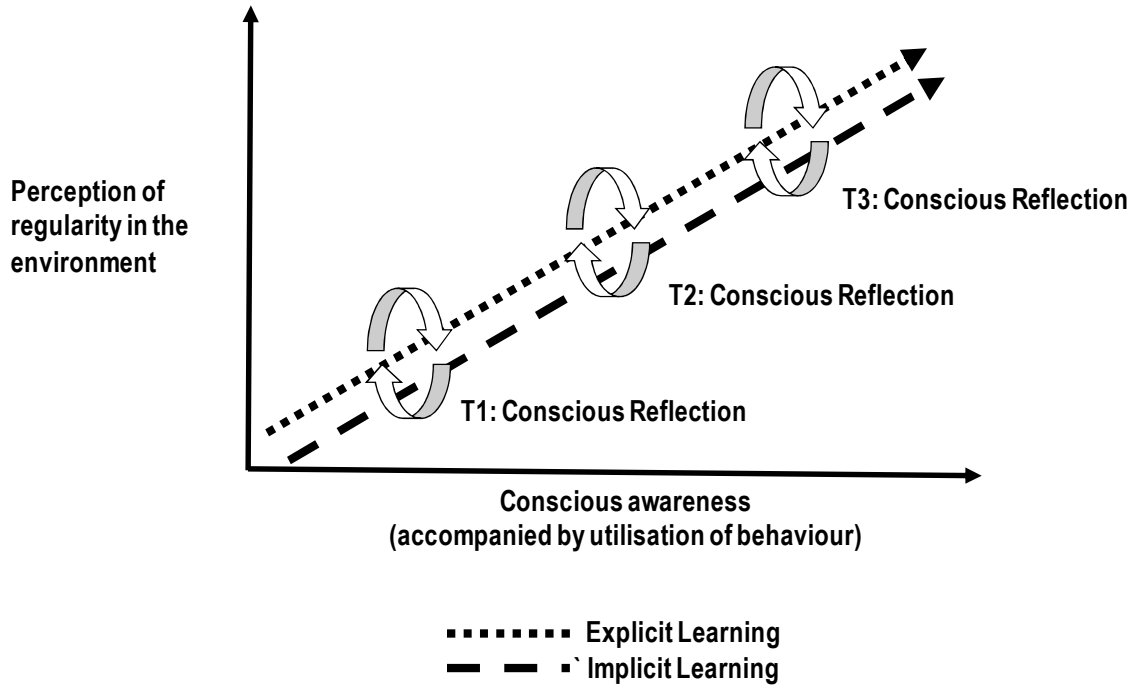


Figure 6: Proposed Adaptive Implicit Learning Model for People on Polar Deployment

Sources:
Block (1995); Cherniss et al. (1998); Cleeremans & Jiménez (2001); Frensch & Rünger (2003)

Implicit learning and non-implicit learning are potentially two parts of a dual process that form a spiral structure for the acquisition of tacit knowledge (Sun et al., 2005). These processes are interrelated, incremental, self-organising, evolving and personal to an individual (Gaillard et al., 2006). Implicit and non-implicit learning may be more interrelated during the learning of complex tasks (Sun et al., 2005) in natural settings.

Taking the acquisition of emotion-related knowledge as an example, although an emotionally disturbed individual may not know how to manage his or her own emotions, he or she might be aware of his or her intention to balance his or her own emotions at a particular time (DeShon & Alexander, 1996), namely the *conscious moment* (see Figure 6). This exhibits a certain *degree of awareness*.

The act of reflection might reinforce the subsequent learning in one of the following ways: implicit learning, non-implicit learning or a dual learning process (Frensch & Rünger, 2003; Sun et al., 2005). In the current study, implicit learning methods refer to incidental learning without intentionality. Degree of intentionality may increase when one introspects and monitors the changes of one's own moods and their impacts on one's own learning behaviours. An example of

this includes observing and interpreting the body language of others to ask for support (i.e., social intuition), or by trial-and-error to develop coping strategies in managing one's own emotions. This Incidental learning may lead to the acquisition of other associated behaviours that may or may not be directly related to the current task. These experiences may be stored in the memory system in a loosely connected form and resulting in a low awareness of their existence (Gaillard et al., 2006). Hence, one may find it difficult to verbalise the knowledge learnt.

Subsequently, an individual may become aware of the meaning and learning needs of learnt knowledge. Given the 'right' stimulus or cues, one may later apply this knowledge more explicitly. This process results in one's ability to express what has been learned (Craik, 1967). As shown in the proposed Adaptive Implicit Learning Model (Figure 6), the learning process at point T2 might not take place until the individual is aware of the need to pick up the cue relating to current learning needs. A similar explanation can be applied to the learning process at point T3.

Consequently, this learning outcome may extend to other associated learning outcome(s), through, again, the cycle of interaction among implicit learning, non-implicit learning, or a dual process (e.g., Destrebecoz & Cleeremans, 2001; Evans, 2003, 2008; Sun et al., 2005). For instance, an individual may learn to reverse his or her negative mood by stepping away to examine the causes of his or her own emotional state and make sense out of it (Leary & Tate, 2010). One may seek other sources of learning more explicitly if and when needs arise at a later stage, particularly on reflection (Greenwood, 1998). The interaction between implicit learning and non-implicit learning thus forms a self-organised, spiral structure (Schaffernicht, 2005).

In other words, this model helps to explain the learning experience of polar personnel, in terms of the range of learning content, such as the social-psychological adaptation issues found in polar literature, as well as the process and methods used by an individual in the polar environment (Savitt, 2005). In addition, it might explain the controversy in empirical studies and methodological issues discussed in Parts 2 and 3 of Section 1.3.3. That is, although each researcher may focus, and truthfully explain, the learning phenomena of an evolving learning process at points T1, T2 and T3 (Figure 6), these experiences might be comparatively and qualitatively different from a learners' point of view. The discussions above imply that implicit learning is an unintentional, contextualised, personal, highly dynamic, self-organising and evolving learning processing where awareness systematically conveys the process (Cleeremans et al., 1998; Frensch & Rünger, 2003; Gaillard et al., 2006). In other words, implicit learning is "a complex, multifaceted phenomenon that defies easy definition" (Gaillard et al., 2006, p. 15).

1.7.3 Emotional Outcomes from 'Novice' to 'Expert'

In view of the discussion above, what initiates a learning process in the Adaptive Implicit Learning Model (Figure 6)? What makes an individual become more explicitly aware of implicit learning outcomes?

A review of the literature in these areas suggested a model to explain the possible divergence between implicit learning and non-implicit learning at points T1, T2 and T3 in the Proposed Adaptive Implicit Learning Model (Figure 6). Adapted from Simons & Ruijters (2004), the Learning related Emotional Effects from 'Novice' to 'Expert' Model (Figure 7) suggests an individual transforms from a novice to an expert through three stages of learning, namely elaboration (E1), expansion (E2) and externalisation (E3). This study focuses primarily on the effects associated with implicit learning in the elaboration stage (Eraut, 2000; Fredrickson 2001, 2004; Simons & Ruijters, 2004). During this stage, an individual may experience a range of emotions such as safety, anxiety, curiosity, interest, excitement and confidence (Simons & Ruijters, 2004). These emotional drivers may initiate and affect an individual throughout a learning process.

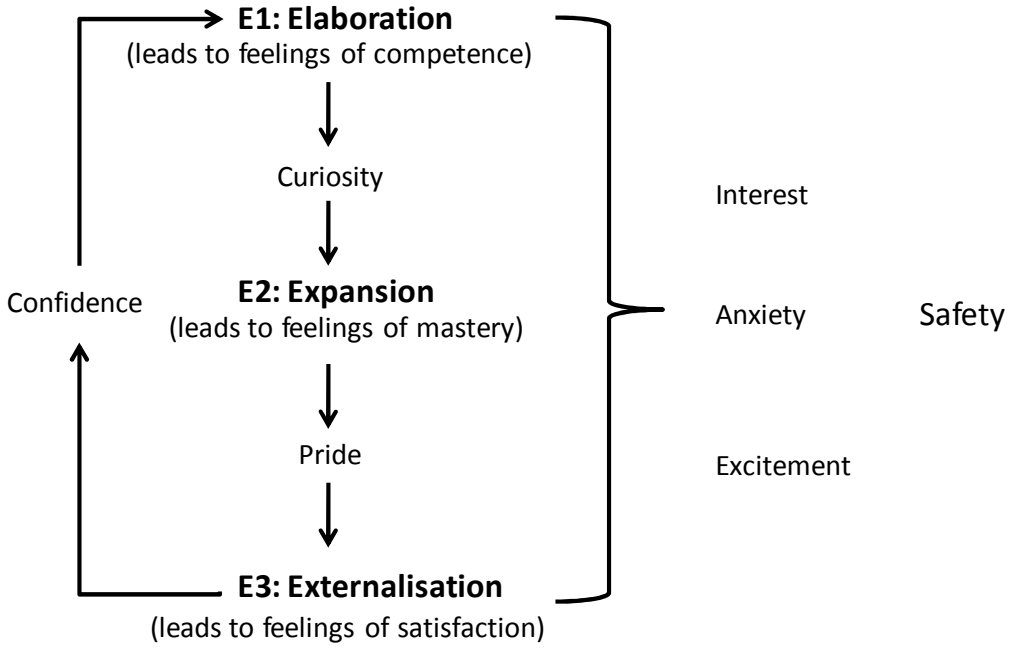


Figure 7: Proposed Learning related Emotional Effects from 'Novice' to 'Expert'

Adapted from: Simons & Ruijters (2004)

Although the term 'expert' in the model above refers to an individual who become sophisticated in mastering a learning outcome in a conventional workplace (Simons and Ruijters, 2004), it carries a slightly different meaning in this study. "Expert" in the current study refers to an individual who has become more aware of the perceived regularity of a learning environment. The first definition is an objective measure of a learning outcome, the latter definition is a subjective measure of an individual learning experience. In other words, perceived regularity of a learning environment may not necessarily lead to an increase in task performance, or emotional and social competencies.

1.8 Research Question and Objectives

Discussion so far establishes the need and the direction for research. This study focuses on the polar scientists and support personnel whose jobs involve the acquisition and utilisation of tacit knowledge during the internalisation and socialisation process of informal workplace learning (Nonaka & Toyama, 2003; Nonaka, 2005) in polar environments. In particular, three types of tacit knowledge found to be critical for the polar life were selected for this study: task, emotional and social-related knowledge (Gunderson, 1973; Taylor, 1985, 1987, 2002; Steel et al., 1997, 2001, 2005; Palinkas, 2003). Investigation of learning experiences of this workforce will help to unfold, share and utilise knowledge for organisational learning (Sternberg & Horvath, 1999; Albino et al., 2001; Nonaka & Toyama, 2003; Høyrup, 2005; Nonaka, 2005; Savitt, 2005).

This leads to the central question of the current study: What is the nature of implicit learning of tacit knowledge in a polar environment? This research aims to identify, analyse and evaluate the:

1. importance of tacit knowledge in a polar environment;
2. acquisition and utilisation of these three forms of tacit knowledge by the polar workforce, particularly with respect to the interplay between learning content and learning process;
3. role of affect in implicit learning in a polar environment; and
4. the perceived critical factors that facilitate or impede the learning and transfer of the tacit knowledge.

1.9 Summary

The review of literature related to tacit knowledge, implicit learning, informal workplace learning and polar research between the 1960s and 2000s suggests gaps in the literature across these fields. The first gap refers to the lack of study between tacit knowledge and implicit learning in polar literature. Though the polar literature covers human adaptation issues before, during and after a polar deployment, no study has investigated how an individual may learn the task, emotional and social knowledge felt to be critical for superior adaptation to the polar work environment.

The second gap stems from the paucity of implicit learning studies outside of the laboratory. Most current research supports the existence of implicit learning in a controlled and a natural setting, yet is inconclusive about the mechanism of implicit learning. Given the versatility of behaviourism, cognitive and constructivism approaches to the investigation of learning concepts and theories, as shown in the Circular Approach (see Figure 2), it is difficult to compare and contrast the findings within an academic discipline and certainly across disciplines. However, an investigation of this nature calls for cross-disciplinary models and concepts associated with consciousness and implicit learning concepts. A further review of empirical studies, methodological issues and theoretical positions associated with consciousness and implicit learning, suggested the current study use a contextual approach and a theoretical framework to study the dynamic nature of implicit learning in the polar workplace.

Three learning models from cross-disciplinary perspectives were adapted for the purpose of this study. The first model, the Informal Workplace Learning Model (see Figure 5), deals with the general context of the polar workplace learning. This context includes the physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments, as well as individual learning (IL) categories of factors. As part of individual learning factors, the Adaptive Implicit Learning Model (see Figure 6) and Learning related Emotional Effects from 'Novice' to 'Expert' (see Figure 7) suggest the process and emotion that may be associated with implicit learning over time.

The gaps in the literature discussed in this chapter indicate a need for the current study to select either a macroscopic or a microscopic aspect of implicit learning for investigation, and how to go about collecting this level of data. Chapter 2 explains the challenges faced in data collection and how the initial research method was modified in view of these challenges.

Chapter 2
Research Methods

2.1 Overview

The first part of this chapter begins with the initial research plan. It explains the challenges encountered and the amendments made before data collection in a revised plan; triangulation of sources, methods and theories for data collection and analysis was employed to examine implicit learning phenomena at an individual level. An open-ended questionnaire, in-depth interviews, archival materials were employed to retrieve data from the polar scientists and support personnel who have gone through the New Zealand Antarctic programmes since the 1970s. This study employs factor and thematic analysis, as well as analytic induction to identify the emerging factors and themes related to individuals' learning experiences. Conceptual theories and learning models are examined in light of the case studies of these personnel. An overview of the demographic background of the respondents is provided in the last part of this chapter.

2.2 The Initial Research Plan and Challenges

The literature gaps in Chapter 1 presented the challenge of choosing between a microscopic and a macroscopic approach to examine the implicit learning by polar personnel in the current study. On one hand, most polar literature to date focused on macroscopic learning outcomes, such as human adaptation in small group conditions (see Section 1.5); no study has looked at how an individual learns to adapt in a polar workplace.

On the other hand, implicit learning studies involve two major paths (see Section 1.3.3). Most of the research in the first path uses objective, pre-determined measures and experiments to test specific, microscopic learning experiences in controlled environments, such as laboratories. The second path looks at implicit learning in a natural setting using two approaches. The first approach focuses on specific, micro-level learning outcomes in a specific natural setting, for example, motor skills, facial expression, or social learning. Most of these studies used objective measures and observation. The second approach comprises organisational studies that examine the macroscopic learning experiences in a specific workplace or profession. Most of these studies investigated individual learning from an organisational perspective. In other words, they considered knowledge management and organisational development factors within an organisation.

The current study aims to contribute to polar literature and polar deployment through the investigation of incidental learning of a wide range of task, emotional and social-related knowledge in polar environments determined by polar personnel themselves. In order to do so, the current study employed a qualitative approach and a proposed theoretical framework adapted from across disciplines (see Section 1.7). Given the fact that polar personnel are the learning agents of their own learning, this study reveals implicit learning from the perceptions of polar personnel using two indications of implicit learning: information and sensitivity criteria. The information criterion refers to the identification and descriptiveness of information reported. The sensitivity criterion concerns the degree of awareness towards the information reported, such as how aware they were before, during, and after the initial stage of a learning event.

The initial plan was to take an organisation-oriented approach and focus on only a cohort of Scott Base support personnel across a polar summer and winter. Two plans were proposed along this line: Plan A (on-site option) and Plan B (off-site option). According to these plans, objective and subjective measures, including a psychological battery, a questionnaire, semi-structured interviews, and participative observation (Plan A only) would be used to collect data related to the task, emotional and social domains of knowledge in order to compare the learning patterns at the pre-, during- and post-deployment stage. In addition, job performance ratings would also be obtained from the Scott Base manager. Psychological instruments, such as NEO PI-R (Revised NEO Personality Inventory) (Costa & McCrae, 1992, 2008), were to be employed in order to measure the psychological traits of the respondents. Through the approach of mixed method and multiple case studies, the selected models will be reviewed and modified accordingly.

However, this led to the challenge of gaining access to the selected data. In order to conduct research in polar environments in the New Zealand Antarctic programme (http://www.antarcticanz.govt.nz; E. Butler, personal communication, July 3, 2009), each principal investigator needs to find research funding for research and logistic support, before applying for the logistic support for deployment from Antarctica New Zealand, which is the main agency supporting New Zealand polar research. Apart from private funding, a principal investigator may go through a science bidding round to seek government funding. Depending on the availability of funding, a bidding cycle may be conducted every one to three years for different needs (E. Butler, personal communication, July 3, 2009). Therefore, a principal investigator needs to design a research method taking into consideration the science strategies prioritised by the government in

each bidding cycle, in order to gain access to data. To date, science strategies in New Zealand continue to emphasise natural science over social science (http://www.frst.govt.nz/news/International_Polar_Year). Without sufficient support and guidance from senior researchers, the process of gaining access can be a very challenging and time-consuming process (Denholm & Evans, 2009).

Both methods proposed in the initial research plan required logistic support and approval from internal and external agencies, such as the Human Ethics Committee (HEC) at the University, the Foundation for Research, Science and Technology (FRST) and Antarctic New Zealand. Unfortunately, a new science bidding system for polar research was introduced before the University's approval of this research plan. Under the new bidding system, it was not possible to gain access to personnel until the next bidding round in the following year. After further discussion with the supervision team, the research methods were amended and resubmitted to the HEC for approval in 2007. While waiting for HEC's approval for the amended research plan, the researcher took the opportunity to complete the Graduate Certificate in Antarctic Studies (GCAS) at the University of Canterbury, New Zealand, in 2007-2008. This experience enabled the researcher to develop valuable technical knowledge, field experience and professional networks related to Antarctica and the science community. In particular, it was useful for the recruitment of the respondents for this study. By then, the amended plan was ready to take effect. The following section describes this research design in detail.

2.3 The Amended Research Plan: Procedures and Instruments

2.3.1 Triangulation of Sources, Methods and Theories

Instead of using objective measures, such as organisational data, and testing the theoretical framework on a cohort of subjects, the new research plan looks at the acquisition and transfer of task, emotional and social knowledge, implicit learning, and learning environments from the perspectives of polar personnel across polar seasons. A triangulation of sources, methods and theories was employed.

Under this amended plan, the subjects for study changed from a cohort of Scott Base support personnel to the polar scientists and support personnel who have worked and lived in polar environments through New Zealand Antarctic programmes between 1970 and 2009.

Data collection also changed from a one-stage process (i.e., one-off recruitment and interview) to a three-stage process (i.e., multiple-recruitment, questionnaire-by-post, and follow-up interview).

The new data collection method comprised three stages. In the first stage, respondents completed a learning-related questionnaire - the core portion of this research. During the second stage, the respondents were given the choice of extending their contributions by participating in a follow-up interview and providing archival materials, such as respondents' photos, drawings and diaries, related to their learning experience. In addition, other supplementary, primary and secondary data collected from interviews with Antarctic New Zealand and Scott Base personnel during the early stage of this study, personal communications, conferences or workshops, field notes, library searches and websites. Figure 8 highlights these processes.

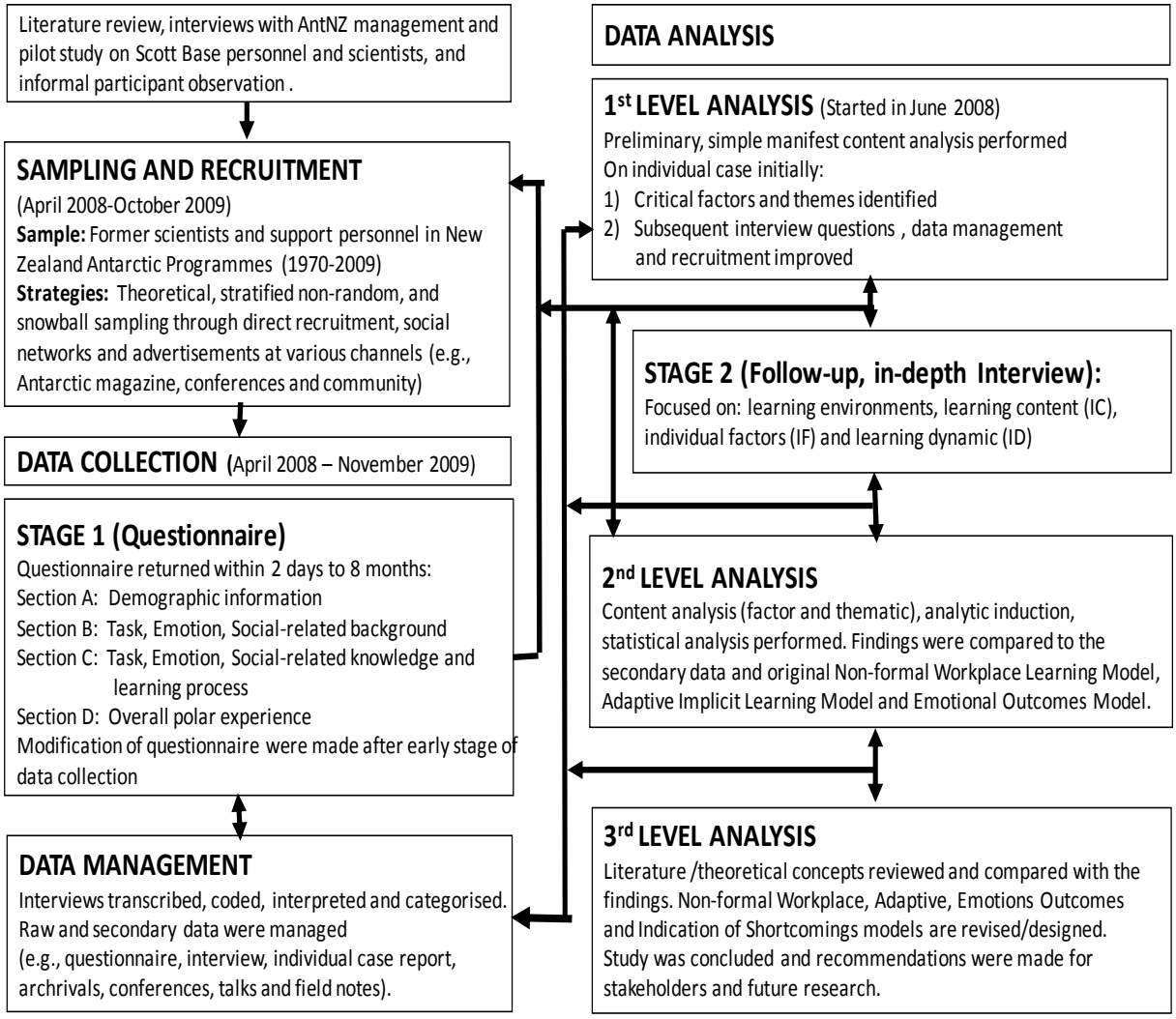


Figure 8: Research Process – Triangulation of Data, Methods and Theories

The current study employs three triangulation methods for data collection and analysis (Flick, 1998; Ritchie & Lewis, 2003) (see Figure 8). Triangulation of sources, such as primary and secondary data, was completed across occupational groups, years of deployment and polar experience. Between-methods triangulation, such as questionnaires and follow-up, in-depth interviews, was applied to enhance and enrich the data collected. The collected data were reviewed using a triangulation of theories. Cross-disciplinary perspectives, such as environmental, social, cognitive and learning psychology, as well as human resource development, provided insights to implicit learning at a workplace. The following sections describe the research design and processes.

2.3.2 Sampling Design and Recruitment

As the physiological and social-psychological challenges faced by polar personnel may be varied, the sampling criterion in the current study has taken into consideration respondents from different demographic backgrounds, for example, occupation, age, sex, number of polar deployments and years of experience. This sampling design helps to increase external validity of the study because it enables a comparison of the learning experiences of polar personnel across contexts.

Theoretical, stratified non-random, and snowball sampling were employed through direct recruitment, social networks and advertisements through various channels, such as an Antarctic magazine, conferences and the community. Of the four groups of respondents shown in Table 1 (Chapter 1), scientists appeared to share the most common social and professional habitats, such as workplace and professional events, after their polar deployments. Therefore, it was logistically simpler to recruit them. On the other hand, it was time-consuming to recruit former support personnel from Groups 1 to 3, because they are often geographically, socially and professionally far removed from each other after their deployment. It is not surprising that face-to-face, email, social networks and snowballing methods appeared to be the most effective ways to recruit individual respondents.

2.3.3 Data Collection

Data collection consisted of two stages, questionnaires and interviews. On expressing an interest in participating, a research package, composed of the research information, consent form and learning-related questionnaire, was posted or emailed to the respondents. A subsequent time and place of convenience was arranged for respondents who indicated a wish to take part in an interview.

Stage 1: Questionnaire

A learning-related questionnaire was designed based on the proposed framework. This questionnaire was given to a small group of scientists and support personnel at Scott Base in a pilot study. An informal respondent observation of the working and living environments at some field sites and Scott Base was carried out by the researcher during a polar summer. In light of the pilot trial and the observation, the questionnaire was amended before data collection.

This self-administered questionnaire, which required a total of 60 minutes to complete, comprised the following sections (see Appendix A):

Section A: Demographic information

Section B: Background information of work, emotional and social life in polar environments

Section C: Work, emotional and social-related learning experiences in polar environments

Section D: Overall polar experience

Apart from the closed questions related to demographic background, questions were open-ended, aiming to identify:

- demographic background of the respondents, such as age, sex, profession, contextual information and the length of their polar deployment(s);
- learning incidents during their first deployment, such as the learning content, circumstances, process and behaviours;
- how similar or different these learning experiences were compared with those in other contexts, for example, conventional environments or subsequent polar deployment(s); and
- the overall experience, such as the forms of support and their advice for first timers on polar deployment.

Open-ended questions were employed in order to reduce the impact of researcher bias and to encourage insights from the participants. In asking about how a learning incident took place, the result demonstrated that the participants often associate a learning experience with a time-frame; this enables comparability of data analysis across cases. For example, Questions 5 and 6 did not explicitly ask about the time-frame of a learning incident, and it was possible that the participants interpreted them in different ways. But the result demonstrated a similarity among the responses. Also, the participants associated a prior learning experience outside of polar workplace with the learning experience during the first polar deployment. This indicates the individuals' tendency to associate learning cues and elements across contexts.

Although the participants were expected to complete the questionnaire, they were advised about their option to opt out of any question that they did not wish to answer.

Scrutiny of the data from the initial round of data collection with the questionnaire indicated a need to provide some specific prompts about learning processes, such as learning methods, in order to gain sufficient data related to these processes. It was apparent that there was a shortage of descriptions about learning processes and a lack of understanding (on the part of the respondents) about what was meant by the term "learning process". Of 35 respondents, 20 responded to the first version of the data collection protocol and 15 to the second, amended version (with more prompts). Interestingly, this change did not seem to bring about a significant increase in the reporting of learning processes. In-depth interviews remained a much more effective way of eliciting data about these processes.

Stage 2: Follow-up Interview

Completed questionnaires took between two days and eight months to be returned. Data were analysed upon receiving the questionnaire. A list of interview questions was designed based on the learning incidents reported. These open-ended questions probed what, where, when, who, how and why such learning incidents took place. Questions that were more specific were developed in light of the dialogue with the participants during the interview. This general-to-specific approach allows broad and deep insights into a learning event based on information from the perspective of a participant. Upon completion of the generic question, the respondents who had signed up for the follow-up interview were contacted for a follow-up interview. Of 24 respondents, two interviews were conducted using

telephone calls because these respondents were geographically far removed from the researcher. The rest of the interviews were conducted in person at offices, residences or other places chosen by the respondents.

A typical interview included three parts (see Appendix B). First, the ethical code of conduct was explained, then a brief description of the professional background of the respondent was requested. After this, the interview moved on to gather information about specific illustrations of learning-related data, such as the situation and process associated with the learning incidents reported by the participants. The average length of interview was 1.5 hours; they were recorded using a digital audio recorder for transcription. Field notes were kept of these interviews. Additional data were provided by respondents at their own discretion either during or after the interview. Archival materials, such as photographs, drawings and written accounts, provided by respondents were used as supplementary data. A note of appreciation was sent to each respondent at the end of data collection. Data collection stopped when the study reached the stage of theoretical saturation.

Stage 3: Supplementary and Secondary Data

Supplementary and secondary data were collected from other sources: personal communication with Antarctic New Zealand and other polar personnel, conferences, talks, lectures, field notes, library searches, websites, human resource handbooks and field manuals for polar deployment.

Data Management

Data collected were divided into two categories. The first dataset is the core data collected from the questionnaires and interviews. They were transcribed, coded, interpreted, categorized and kept in both hardcopy and electronic form. Although the qualitative software, NVivo, was used during the early stage of data management and analysis, conventional methods, such as Microsoft Excel and Word, were chosen during the later stages of analysis and writing because they appeared to provide more flexibility. The second dataset comprises the supplementary and secondary data collected from other sources mentioned above. Photographs, drawings and written accounts were for some respondents in describing their past learning experiences. Other primary and secondary data, such as field notes and research diaries, were useful for reflective thinking before, during and after the event. Chapter 4 will discuss the methods of analysing the data.

2.4 Respondents: Demographic Results

This section presents an overview of the demographic background of the respondents in this study, i.e., their occupation, sex, age, ethnicity, polar deployment and experience.

2.4.1 Respondents by Occupation, Sex, Age and Ethnicity

Between 2008 and 2009, 69 research packages were sent to individuals who expressed an interest in participating. As a result of failure to respond for personal reasons or the loss of questionnaires through post, 35 participants returned their completed questionnaire (i.e., 52% response rate). Twenty-two of the 35 respondents (i.e., 63%) took part in the follow-up interview (see Figure 9). Of these, 11 were scientists and 11 were support personnel. Eight of 22 respondents (i.e., 36%) provided supplementary data in the form of personal materials such as photographs, drawings and written accounts, either during or after the interview. At the time of data collection, the mean age of the 35 respondents was 41 years old (σ = 13.49), with a range from 22 to 76 years old. Apart from one Asian, they are all Caucasian.

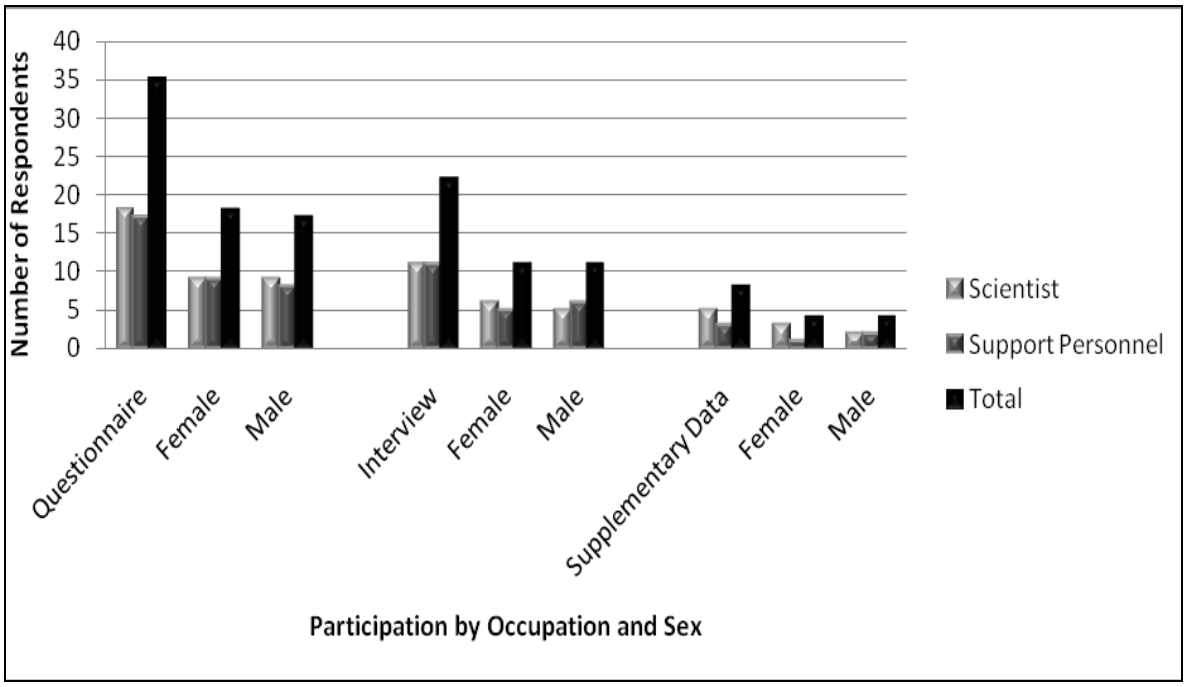


Figure 9:
Participation by Questionnaire, Interview and Supplementary Data
- A Summary of Participants' Occupation and Sex

2.4.2 Respondents, Polar Deployment and Experience

Respondents in this study can be divided into four groups, depending on the nature of their deployment: Scott Base specialist team deployed by Antarctic New Zealand (Group 1), New Zealand Defence Force personnel (Group 2), science support or tradesmen from other non-Antarctic New Zealand programmes (Group 3) and scientists deployed by non-Antarctic New Zealand (Group 4) (see Table 1 in Chapter 1). The majority of the respondents were from Group 4 (51%), followed by Group 3 (26%), Group 1 (17%) and Group 2 (6%). This indicated that 77% of the respondents (Groups 3 and 4) may not have gone through formal psychological assessment during a deployment selection process.

The general work nature of Groups 1 and 2 is service-oriented (see Table 1). The main objectives of these groups are to maintain base facilities and to provide support for science projects and field activities. Due to their work roles and the operation of Scott Base, they are different from Groups 3 and 4 in at least two ways. First, Groups 1 and 2 may benefit from high levels of logistical proximity to the communication, management and technical support from New Zealand. Secondly, they may experience a lower level of work autonomy and control (i.e., clearer division of labour and chain of command) compared with Groups 3 and 4.

Table 3: Job Categories and Job Descriptions of Groups 1 and 2 Respondents at Scott Base

	Job Categories	General Job Description	Positions
Group 1: Scott Base Specialist Team Deployed by the Antarctica New Zealand			
1	**Operations**	To assist all New Zealand science projects and field activities	• Winter-over manager • Programme Support Assistant • Field Training Instructors • Field Support Coordinator • Field Support Assistant • Science Technician
2	**Engineering**	To operate and maintain buildings, services, plant and vehicles at Scott Base on a daily basis	• Engineer • Mechanic • Electrician • Carpenter
3	**Base Services**	To carry out all administrative and domestic activities at Scott Base	• Chef • Cleaner (Domestic)
Group 2: Other Support Personnel in Scott Base Deployed by the New Zealand Defence Force			
1	**Operations**	To support all New Zealand science projects and field activities	For example, cargo handler and post office

Sources: Antarctic New Zealand (2008c); Tan & Steel (2008)

On the other hand, Groups 3 and 4 are science-oriented. The main objectives of these groups are to carry out or to support approved science projects. The majority of their work involves data collection in outdoor conditions. Due to their work roles and workplace, they may encounter limited resources and support, unpredictable weather conditions, and a high level of work autonomy and control with regard to their fields of expertise during the deployment.

Depending on the needs and support for science and special projects, a typical polar deployment may range from a week to a year (M. Lindroos, personal communication, January 16, 2008). Groups 1 and 2 support personnel may be deployed for the summer (October-February) and/or winter (March-September); Groups 3 and 4 are deployed primarily during the polar summer and varied by number depending on the science projects (M. Lindroos, personal communication, 2008). The average size of the Scott Base crew (Groups 1 and 2) is approximately 35 during summer and fewer than 20 during winter (Harrowfield, 2007). All four groups operate at and through a research station such as Scott Base.

First Deployment Year

The respondents were divided into four groups, based on the year of their first deployment: Group 1 (1970-1980), Group 2 (1981-1990), Group 3 (1991-2000) and Group 4 (2001-2010) (see Figure 10). Most respondents came from Group 4 (54%), followed by Group 3 (20%), Group 2 (17%) and Group 1 (9%). Apart from six scientists whose first deployment was with an Antarctic programme other than New Zealand's, the rest were deployed by New Zealand Antarctic programmes during their first deployment.

As discussed in Chapter 1, the New Zealand polar workplace and workforce appear to have undergone significant changes in various aspects, such as legal-political, technological, social-cultural and resources, during the last 50 years (Harrowfield, 2007). For example, the New Zealand and international female polar workforce appeared to increase significantly recently (Harrowfield, 2007; Baeseman, 2010). Thus, approximately 66% of the respondents (i.e., Groups 3 and 4, excluding the 6 scientists from non-New Zealand programmes) worked in relatively similar environments in the years since 1990, compared with those before 1990. Most respondents started their polar deployment at a similar age. The average age was 31 for scientists and 30 for support personnel, range 20 to 46 years.

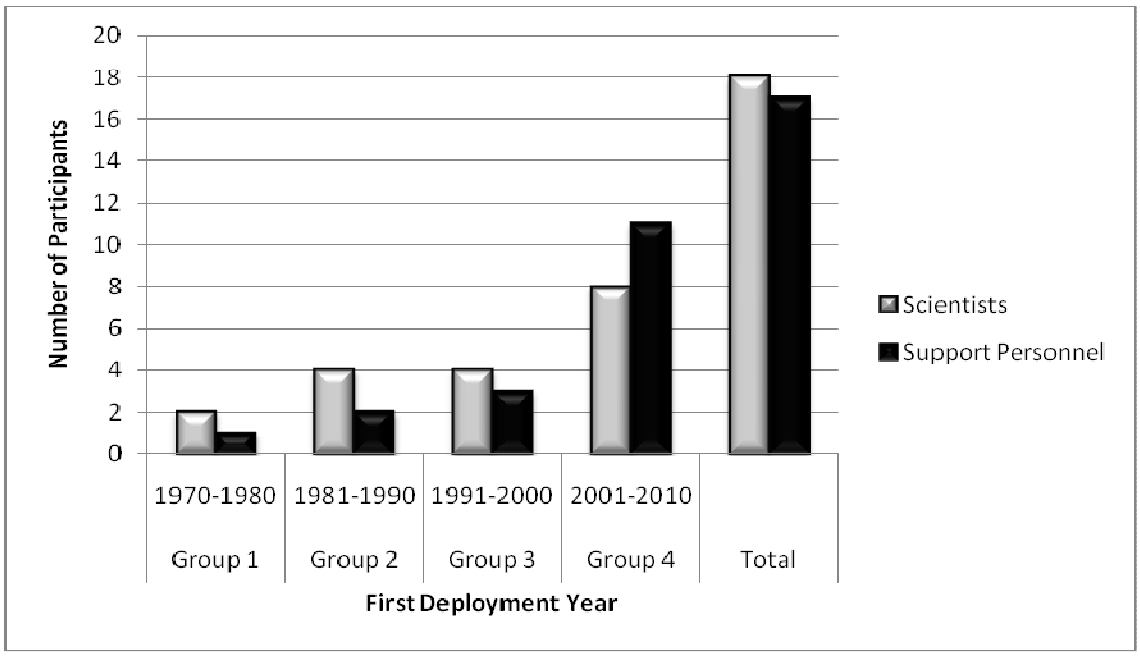


Figure 10:
Distribution of Respondents by First Deployment Year in Antarctica
- Categories of Polar Personnel (n = 35)

Notes:

Category	Description
Group 1	Scott Base specialist team deployed by Antarctica New Zealand
Group 2	New Zealand Defence Force personnel
Group 3	Science support and tradesmen deployed by non-Antarctica New Zealand organisations (e.g., science technicians for special projects)
Group 4	Scientists deployed by non-Antarctica New Zealand

First Deployment Season, Work Site and Crew Size

Eighty percent of the respondents were deployed for their first time during the summer (see Figure 11). Two out of 18 scientists and nine out of 17 support personnel spent their first deployment wintering over.

The site where the respondents worked ranged from research stations (14.3%), field sites (3%) and vessels (11.4%) to a combination of stations and field sites (54.3%), as well as a combination of all venues (17%). Apart from the 86% of the deployments spent in the Ross Sea and Southern Ocean regions, the deployments were on the sub-Antarctic islands and Antarctic Peninsula. Of the 35 respondents, 17 spent most of their time at Scott Base; only a minority of respondents worked in deeply in the field.

In terms of crew size, 49% of the respondents worked in small crews (≤ 15 people), 29% in moderate size crews (16-40 people), 11% in large groups (≥ 40 people) and 11% in both small and large crews during the polar deployment.

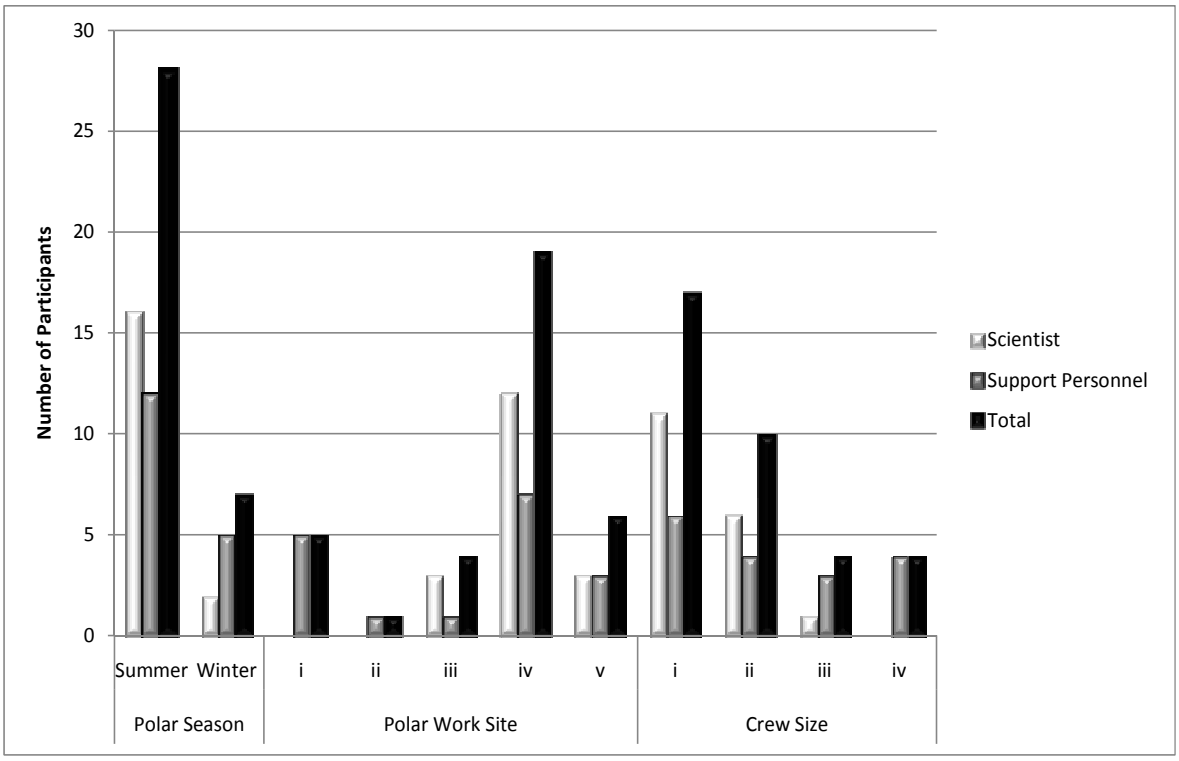


Figure 11:
Distribution of Respondents by First Polar Deployment
- Polar Season, Work Site and Crew Size (n = 35)

Notes:
Polar Season: Polar Winter or Polar Summer
Polar Work Site: i = station, ii = field site, iii = vessel, iv = station and field site, v = all
Polar Crew Size: i = small (≤ 15 people), ii = moderate (16-40 people),
iii = large (≥ 40 people), iv = polar year (small and large crews)

Polar Experience To Date

The average cumulative length of polar deployments at sample date was 43 weeks, range four to 380 weeks. Based on the average cumulative time, a six-month (or 24 week) polar experience was used as a separation point to differentiate "novices" from "old hands". Similar to a polar study by Steel (2000), the rationale for this cut-off is based on the fact that the majority of polar deployments are less than 6 months. Only polar personnel who were deployed for the whole polar winter or at least one polar deployment are likely to have more than 6 months polar experiences. Of 35 respondents, 19 (54%) were novices and the rest were "old hands" who had spent more than six months in the polar environment (see Figure 12). In light of the findings in the current study, note that "novice" and "old hand" refer to different criteria in Chapters 3 and 4. The average number of polar deployments was five, range 1 to 17 deployments over 38 years (1970-2009).

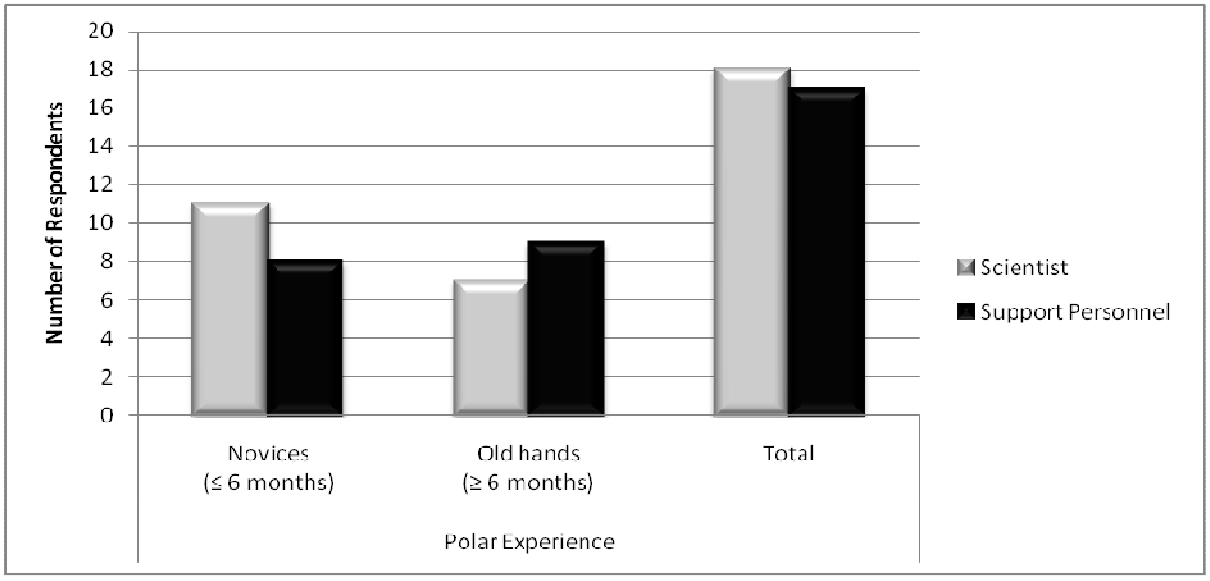


Figure 12:
Distribution of Respondents by the Length of Polar Experience -
'Novices' and 'Old Hands' in Polar Workplace(s) (n = 35)

2.5 Summary

This study employs a triangulation of sources, methods and theories. Data were collected through a structured, open-ended questionnaire, in-depth interviews and archival materials collected from the polar scientists and support personnel who have gone through New Zealand Antarctic programmes between 1970 and 2009. Supplementary and secondary data were assembled throughout the research. Although a triangulation approach might help to increase the validity and reliability of the study, it is a strategically integrative, cyclic, meticulous and time-consuming process.

The majority of the scientists and support personnel in this study shared similar demographic backgrounds, in terms of their ethnicity and age, during their first deployment. Sixty-six percent of the respondents worked in relatively similar external business environments after 1990 during their first polar deployment (see Figure 10). Eighty percent of the respondents were deployed during polar summer. Fifty-four percent of the respondents spent most of their time at both the research station(s) and field site(s) during their deployment.

The following chapter will present the methods of analysis, followed by the key findings of the data collected, such as learning environment, content and process.

Chapter 3
Results and Discussions

"I had to learn to pull myself out of the mud by my own hair. I really don't know how and when I realised that, it seems now that this realisation just happened."(S7)

3.1 Overview and Data Analysis

This chapter begins with the presentation of the analysis method used in this study, followed by three major findings from the collected data. Please note that a few quotes appear twice in this chapter. This is because these quotes contained particularly illustrative examples of more than one theme.

The first finding introduces the patterns of implicit learning and a new learning model (Figure 13) for the polar workplace. It redefines the concepts of time and learning environment based on the results. It also takes into consideration the revised models of Adaptive Implicit Learning (Figure 6) and Learning related Emotional Effects from 'Novice' to 'Expert' (Figure 7) in Chapter 1. The elements embedded in the sub-models will be discussed later as the disparities of learning. The second findings are associated to task, emotional and social-related learning content and processes. Learning content and processes are varied in terms of their range, frequency, ease and descriptiveness of reporting.

The next finding concerns the concept of disparities as drivers of learning. Transfer of learning takes place when an individual closes the learning gap(s) between an 'original context' and a 'transfer context'. Disparities that served as drivers of learning are divided into two types. The first type involves a learning environment. Common themes, such as the perceptions of isolated, confined and extreme conditions, small group attributes, as well as the border between work and non-work, will be presented. Further analysis suggested that deprivation of privacy and scarce resources in a polar workplace may reinforce implicit learning in I.C.E. conditions. The second type of the disparities concerns the learner. One may or may not pick up a particular learning resource and learning cue based on his or her perceptions and interpretation of the elements in a learning environment. In this section, disparities such as individuals' perception and sense of unusualness, time, learning cues and intensity (context intensity and learning intensity), as well as emotion associated with implicit learning, will be reported. In view of the results, a summary is presented at the end of this chapter.

Data Analysis

Based on a multiple case study approach, constant comparison and disconfirmation of analysis were applied to the data collected. Two levels of analysis process, stated below, were employed and documented throughout the research.

First Level of Analysis

In the initial stage, the data collected from questionnaires were reviewed. Preliminary, simple, manifest content analysis was performed within cases and across cases in order to identify the critical factors and themes. During this stage, results demonstrated that all learning experiences reported consisted of learning content, a learning process, and a learning environment. A wide range of learning content was reported. However, it was evident that some participants were less descriptive about the process they went through in learning a content.

This finding helped to inform the design of interview questions and the ways to manage the collected data. In particular, more specific questions were asked about how, when, where, who, and why a learning process associated to a reported learning content took place.

Second Level of Analysis

At the second stage of analysis, data collected from the follow-up interviews were transcribed, coded, interpreted, categorised and compared with data from the questionnaire. Simple descriptive statistics were used to give an initial overview of the quantitative data. Thematic analysis and analytic induction were employed in order to identify the emergent factors and themes.

Analytic induction method (Flick, 1998) was employed throughout the first and second levels of analysis process. Starting with the formulation of a rough definition of the implicit learning phenomenon, a hypothetical explanation of the phenomenon was generated. The first case was studied in light of the hypothesis. This was followed by systematic, continuous study of additional cases until practical certainty has been obtained. The process of data collection and conceptualisation continued until categories and relationships were 'saturated'.

Besides confirming results reported in the first level of analysis, the second level of analysis enriched the understanding of processes used in the acquisition and utilisation of learning content. The resulting themes were compared with demographic variables such as occupation, sex, age, and polar experience (i.e., polar novice or old hands, and deployed sites) of the contributor. Although

reported learning content varied by individuals, descriptiveness and sensitivity toward a learning process appeared not to be associated with occupation, sex, age, and polar experience.

Further analysis examining the individual's perspectives about his or her own learning experiences led to the following themes:

First, although reflected learning experiences were primarily focused on the participant's first polar deployment – the point where every participant was 'new' to a polar deployment – some participants also reported similar learning experiences beyond the first polar deployment. In other words, learning may transfer from one context to another. Although initial learning is often driven by the *disparity* of learning environment factors, learner factors, and learning process factors across contexts, prior learning is usually applied where *similarities* in these features is perceived. Some of these learning experiences may not necessarily derive from events encountered during the first polar deployment. For example, although a participant may came into contact with a crew prior to, or during, a polar deployment, the social learning content and process may not be entirely novel to him or her because of previous experience in similar situations.

Therefore, it may be more appropriate or useful to define the terms *novice and old hands* by the degree of conscious awareness of one's own learning experiences and learning process, such as a need to learn and the disparity of learning across contexts, the learning principles and direction of learning transfer one used, rather than by occupation, age, sex, length and frequency of polar experiences. Although learning content reported may vary by individuals, results demonstrated that most participants went through similar learning stages, regardless of demographic characteristics or deployed sites.

However, not every experienced polar expeditioner was an "expert" in every task, emotion or social learning condition during his or her first polar deployment. Nor was every inexperienced expeditioner "novel" to every learning condition at the time of his or her first polar deployment. For example, a person may learn how to adjust, socialize, or being more 'tolerant' to others, in other similar conditions prior to a polar deployment. These conditions may include co-habiting with 'strangers' or living within a small, isolated community. When one recognises the learning cues across contexts, one may become more sensitive to one's own learning patterns. Although learning experiences in a polar deployment may be affected by the degree of *context intensity* in a polar workplace, and *learning intensity* from the perspective of a learner, general learning principles appear to transfer by some participants across contexts. A majority of this learning was habitual,

experiential learning that may be modified across contexts. More details will be discussed later in Chapter 4.

On one hand, by studying heterogeneous groups of sample, the current study benefits from capturing a wider scope of learning experiences in a polar workplace. One the other hand, it poses challenges to analyse and present the findings. Although not every participant was at the same stage of a learning process at the time when he or she acquired tacit knowledge during the first deployment, results indicated that, despite a wide range of learning content reported, learning process to acquire these contents went through a similar learning cycle: automation, learning-in-action and after-event learning (or unlearning). As well, results in the first and second levels of analysis suggested that disparity of learning and learning associated emotions appear to contribute to implicit learning. Therefore, instead of separating the findings by participants' demographic characteristics, this chapter presents the combined results of learning experiences according to the themes verified across cases in both levels of analysis.

During the final stage, draft results were written during the cyclical process of refining the coding system and the classification and analysis of data. Some of these preliminary findings were discussed and reviewed by peers at conferences between 2008 and 2010, before further analysis and write-up. The results demonstrated a need to search for further literature that would explain the diverse learning content and learning transfer reported by the participants. Learning concepts and associated factors were reviewed, analysed, documented, and amended in light of the data collected throughout the research process. An example of these concepts was Identical Element Theory. In light of these findings, further literature was reviewed and applied to revisions of the original models.

3.2 Patterns of Learning: Revised Models

Learning Cycle and Curve

Analysis of the qualitative data suggested a need to amend the original learning model (Figure 6) in three ways. First, considering the time-frame is essential. Second, learning occurs in a much more curvilinear manner (see Figure 13). Third, prior learning experience seems to impede implicit learning by allowing acquisition of 'new' knowledge without awareness.

In the revised model, *time* is defined as the interval between two similar learning incidents. Two intervals were perceived differently by the respondents. The first duration is during the first polar deployment. The second one refers to the learning across contexts, before and after the first deployment, especially including any similar, prior context(s) and subsequent deployment(s).

An example of the first type is given in the following remark by T10:

> *"I was learning different things...some of the things that I needed to know are sort of internal to Scott Base, like the relationship between me and my roles, and the other roles. So I needed to learn how people work...the personality that goes with the roles. How to work with them, and how people operate...within a role. I knew what the role was, but people interpret their roles very differently."*(T10)

The second type is evident in these statements:

> *"...there has been quite a* ***time gap between the two of them****, that I think it's just a matter of me growing up in a way to being older and to have had those experiences. Like [the] idea that I could be extroverted and not the shy person in the room. And then I have been in other situations, may be not such a big change or whatever, but in between those things before I went back to Antarctica again. So it wasn't a question of needing to learn similar things again; it's just part of my history."* [emphasis added] (T6)

> *"It [first occurrence of implicit learning] sets the base line. The subsequent time when it occurs, that's the starting point. And if things have changed or need to be modified, then it gets modified to suit. The first instance normally set the state for the whole thing.*

...I have changed. But the basic approach is still the same. It's building on what I have already learnt. A lot of it is due to what is observed around me, and a lot of them it's my personal experience of what happened to me in the past, in the previous deployments and so on. ***It's a constant learning curve. You always are learning something here. But it's not a complete change of direction. It's a general modification."*** [emphasis added] (T13)

These two intervals appear to give rise to different perceptions regarding the originality of the content and processes. When considering only the first deployment, the degree of novelty appears to the respondents to be high. However, when they consider the second time-frame, the degree of novelty decreases because they identify similar elements among the contexts. Therefore, the perceptual frame is crucial whether it is elicited by another person, or by the respondents themselves upon reflection.

In the second time-frame, the direction of application of prior knowledge and processes is normally from the conventional to the polar context. For example, one of the respondents, who worked in an isolated and confined environment for about 30 years before his first polar deployment, reported such a transfer:

"So this [place] is exactly the same. The only difference is that when I look out the window, it's dark, but everything else is identical. I go to work in the dark, I worked in the building with fluorescent lighting, and I go home and it's dark again. So to me, there is nothing different. It's just a different place to be doing it. I was working [in this conventional work condition] for nearly 28 years before I took up the first job down here [first polar deployment]..." (T13)

However, after spending an average of eight months per year in polar environments for the last 15 years, learning can flow in the other direction. For example, the respondent who gave the quote immediately above reported a transfer of social learning from polar to conventional environments:

"It's kind of weird, believe it. I have taken a lot of things that I learned down here and adopted them in life back there [non-polar environments]. It has made life a lot less hectic and stressful." (T13)

One of the most striking types of learning that arises during this second, longer interval has to do with changes in one's sense of self and one's place in the world or, rather, how one interacts with it. Some respondents reported conscious awareness of the use of their own mental models and learning principles across learning contexts and time. During the transfer of learning, criteria that carry meanings to them were either created or modified for day-to-day decision-making and problem-solving. These criteria seem to affect their interpretations of self and the reorganisation of their own world views. That is, perception of a subjective experience appears to be a negotiation process within possible selves.

In a comment about how he would handle an interpersonal conflict that he had encountered during the first deployment, T11 describes a past self based on a present or an ideal self:

> *"But now I would be more relaxed...Because I am older...Perhaps not older, but more experienced...I never talked to specialists, perhaps psychologist about that. I don't know. Perhaps it will be just the same. I will just flee out again...just by getting older...not older people are just necessarily better...but I think my personal view, now that I have of a lot of other people in other situation, I will just see it in a different view. I think I could...I can do better. But it doesn't really help...I am not in the situation anymore and at that time I haven't have the knowledge."* (T11)

Although these reflections are most evident in the second time-frame, they can also occur within the first deployment, through either a simple reflection or complex reflection. When talking about his first deployment, for example, S1 reported:

> *"Being able to be focus on things much more clearly. As if there's the purity of thought, if you like, which applies to your self-examination. You see yourself more clearly because of the starkness of what is happening around you. So you are able to focus more on you. When you are staying in the middle of the rock or the ice shelf, you really have nowhere else, as far as yourself."* (S1)

Because reported implicit learning appears, at most times, to depend on prior learning experience(s), conscious awareness of a learning experience may vary. Prior learning experience appears to facilitate implicit learning by allowing acquisition of 'new' knowledge without awareness. This has an impact on the perception of the environmental features that were an integral part of the original model. The model better describes implicit learning if *perceived regularity in the environment* is redefined as the *conscious moments of learning cues.*

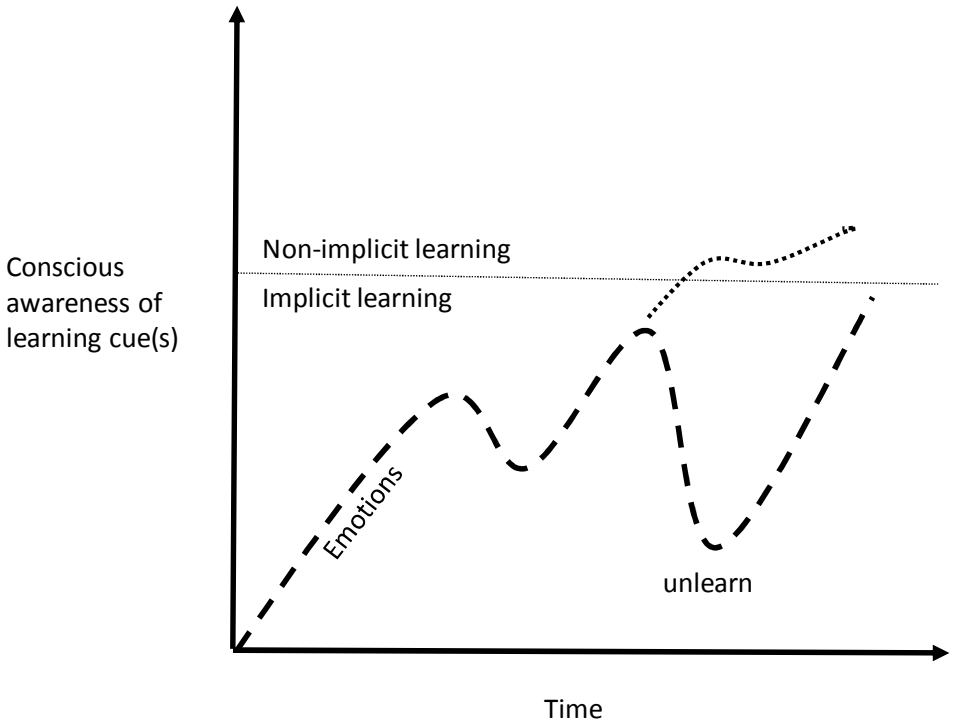


Figure 13:

Model B - Revised Adaptive Implicit Learning Model for People on Polar Deployment

Notes:
Time t = Perception of learning incidents during the first polar deployment
T = Perception of learning incidents across contexts

There are certain commonly reported themes associated with both types of intervals. These themes are automation, learning-in-action and after-event learning (or unlearning).

Automation. During the initial learning, an individual may be overloaded with 'incoming' learning cues and may not have sufficient time, capability, energy or attention to process, verbalise

or rationalise them in detail. Such automation is essentially a lack of awareness of learning the content, as well as the process by which the learning took place. Three respondents gave examples of this when describing a particular learning episode:

> *"I had to learn to pull myself out of the mud by my own hair.* ***I really don't know how and when I realised that, it seems now that this realisation just happened."*** [emphasis added] (S7)

> *"...OK, you got the job done.* ***It got filed away in the back of your mind*** *or your notes or whatever 'record' that you kept…the next time when you came across the thing, this is the way you do it.* ***Or you start to do it anyway. But it will not be remembered per se****..."* [emphasis added] (T14)

> *"I don't remember this. I think it's a continuing process."* (S11)

Similarly, upon reflecting on a social learning experience in a polar workplace, T6 said that:

> *"I am used to being in the [conventional] environment where it is male dominated and that's fine. I don't have a problem with that.*
>
> *But being the only woman in the group is a little bit different again. And I think...****on reflection, I mean this is something like thinking it through later,*** *I think I ended up making sort of strong alliance with one, or often one or two people, and sense of like having a boyfriend sort of things to make my position really clear, so that I wasn't sort of being available to the whole group...I don't, nobody make me feel vulnerable like that. There wasn't a sense of "I need protection" from these terrible men. Not at all.* ***But I guess, it was subconsciously, something like that...I don't know****…****When I looked back, I think "Really? Did I really think like that?" It happened like more than once...the next time I went down, something similar****."* [emphasis added] (T6)

Learning-in-action. A second theme is defined by an increasing awareness of learning while engaging in the action associated with that learning. Post-event reflection moves this dim awareness into full awareness at a later stage. Two respondents gave examples of this stage when describing a particular learning occasion:

> *"I think* ***when you become familiar, there might be different examples, something that you are dealing with. But in your mind, something else clicked and ...well you have been to the same path before and it gives you something to draw on when you are going through the decision making process. Because you are responsible completely for the decision that you are making, to whomever*** *you are answerable for...you are not bouncing ideas around the people. Drawing on some of your great experience than yours,* ***senior*** *to you in making that decision.* ***You are just relying on everything that you can draw on from your experience.****"* [emphasis added] (T12)

> *"...it comes back to what I said about* ***reflection****.* ***At the time that I just did it, and didn't****... I wouldn't think "Now, how am I going to deal with the situation?"* ***I would have just thought "OK" and then do this****... **I guess most of those strategies with things that happened the first time and then I could reflect on them afterward..."OK, so that sort of worked." And then maybe a bit more conscious that I will do that a bit more deliberately in the subsequent times. But I would probably just do the same thing.****"* [emphasis added] (T6)

As suggested in the quote below, such learning is often associated with changes in the intensity and type of emotion the respondent felt at the time of learning.

> *"Excitement... Anxiety... Relief... it has a lot to do with the job...[emotion] fluctuated a lot, in particularly at the start, just because each task to be done has the chance to be anxious and each time when I completed the task, I feel relief. Each time I interact with people related to that task, it's the chance to feel happy if it worked out."* (T11)

After-event Learning or Unlearning. After an act, a lack of usage and exposure to similar learning cues or fewer stimuli may result in a drop in the awareness of the learning that has taken place. For example, when one returns 'home', fewer stimuli may push the awareness of the learning back down to a point where it appears one has forgotten it.

When commenting about emotional learning during his first polar deployment, for example, T13 stated:

> *"I don't know. I don't think so**. It could have been something that happened in my job. It sorts of put me on the edge.** I don't think in that particular area that I can recall. I do recall about 2-3 days I don't really want to talk to anybody... **I find it really hard to describe my learning processes. I just know that I have done it..."***

T13, however, reported a sharper focus of such a learning experience in polar environments compared with conventional environments:

> *"This sort of lesson may be **learned back home, but it would most likely be absorbed in the day-to-day category of things and not become important..."** [emphasis added] (T13)*

Alternatively, increased demands for the learned content may raise the awareness of learning, so much so that it becomes explicit. For instance, the respondent quoted immediately above reported an awareness of after-event learning of performing a task during a polar deployment:

> ***"**Down here, it becomes significant because...There was no way I could ask anyone else how they would have done it. Because nobody else had done it before. I learnt the in and out of how to do it. The next time it was done totally different."* [emphasis added] (T13)

In addition, these increased demands, or even the simple awareness of having learned the content, may prompt the polar person to increase her or his knowledge even though he or she may not perform a task or engage in an act. This is particularly apparent for learning processes; the ways a person has learned.

"...most of them were things that I realised why I was doing it later on. That was the reflection. But what I was going to do happened in the same way each time. I might be more aware that such and such situation is going to come up and I will probably respond like this...It's emotional. It will be like this...like the gut reaction...Because it's sort of instinct." (T6)

3.3 Learning Content and Processes Reported

Task, emotional and social-related learning content and processes reported appear to differ in terms of their range, frequency, ease and abstractness of reporting.

On the whole, repondents appear to be more ready and descriptive when reporting a task or social learning content and process than with emotion. Reporting of emotional learning appears to be the most ambiguous, followed by social and task learning. Emotional learning is often embedded in the act of engaging in a context and it is not always obvious to an individual during the initial stage of the learning process. Upon reflection, one of the respondents gave such an example:

"I had to think hard about these 'emotional lessons' because I think this probably happens, more than all the previous examples, in the subconscious." (S7)

Some respondents correlate the ease of reporting to the length of their deployment and their familiarity with the polar environment, as well as to the specific incidents or people that triggered their emotions. This realisation usually happened after an initial learning incident, especially when they had to verbalise the event. When describing a specific social learning episode, T6 gave an example of this form of realisation:

"...one of the things I realised in answering the questions is that there is a lot of things about how embarrassed I felt about doing things or how I sort of feel like I am standing out, you know, because I am clumsy or whatever. It's about realising that I did something and maybe I was embarrassed about it or it was difficult and then thinking that OK next time I won't do it like that...But that time was embarrassing." (T6)

Most respondents reported interrelationships among task, emotional and social-related learning in I.C.E. environments. When describing the interplay between task and social learning in a polar workplace, for example, T5 stated:

> *"There are not **many situations where you live fully** – including socialising at your workplace and **hence it's difficult to separate the two."*** [emphasis added] (T5)

The majority of the learning content comprises social learning categories (i.e., 38), followed by task (i.e., 27) and emotional (i.e., 25). Due to the perceived changes in social learning environments, such as changing crew compositions, social dynamics, personality and individual learning approaches, social learning appears to be the least structured, the least predictable, and the most challenging type of learning to be acquired by individuals. The dynamics of social learning are evident in the statements from two respondents below:

> *"Every deployment results in **a different group of people. I'll just have to work on this every time**...Living with 16 other individuals in an isolated site for one month. This fact has already highlighted the importance of learning. Also, being my first deployment, the need to learn is even **more acute... Because each individual expresses themselves differently**, I have to watch out for 'tell-tales' signs, [for] example, someone who is frustrated because their equipment was not working properly, resulting in less samples collected for research. Or someone with pre-existing medical conditions which flared up and required assistance in work previously planned.**"*** [emphasis added] (S9)

> *"When I go to Antarctica, people will say "Oh! Aren't you worry about being cold?" for instance, I don't even think about it. I don't worry about that at all. I worried about "Am I going to get on with this group of people". **I think it is easier in the subsequent deployments but that is still the biggest thing for me.** Am I going to get on with these people? So I know **"Yup! I have done it in the past, but this is a different group of people" So is it still going to work?"*** [emphasis added] (T6)

The dynamics of social learning seem to derive from a changing need to deal with different interpersonal relationships and individual differences, such as personality. When describing how social interactions were developed throughout a polar summer, for example, T12 stated:

> *"It's always interesting how things work or don't work, and* ***personality is probably the biggest*** *thing that comes into that...I think personality comes into a lot of problems down there."* [emphasis added] (T12)

Within these categories, 91 examples reported applied to social learning followed by emotional (80) and task (77). The following section presents these findings in detail.

Learned Content Reported

As mentioned in Section 1.6, task, emotional and social learning content is suggested to be *descriptive knowledge* (also called declarative or 'know what' knowledge) (Smith, 1994; Yang, 2003). Most of the learning content is associated with problem-solving, decision-making and spontaneous learning incidents. According to the respondents, the three domains of abilities (Gunderson, 1973) covered all aspects of learning during a polar deployment. As shown in Table 4, below, of 248 examples reported, social-related knowledge was the most frequently reported example, followed by emotional and task-related knowledge. Scientists appeared to report comparatively more examples of emotional-related knowledge than support personnel.

Table 4:
Task, Emotional and Social-Related Knowledge
Reported by the Respondents on Polar Deployment

Category of Tacit Knowledge	Number of Examples Reported		
	Scientists	Support Personnel	Total
Task (T)	38	39	77
Emotional (E)	45	35	80
Social (S)	46	45	91

Of the task-related examples reported, support personnel tended to report on both technical and organisational factors, whereas the scientists reported mainly technical aspects. The majority of the categories reported by all respondents were related to physical, social-cultural

learning environments. The most frequently reported examples are directly associated with I.C.E. conditions.

One of the major themes concerned the ways to perform a task in a field. Faced with bad weather or scarce resources, support, information, equipment and tools, respondents modified their work methods, instruments, equipment and tools, as well as the ways to keep warm and handle unfamiliar conditions, workmates or equipment. When asked about his learning experience, for example, T13 explained how he learned to adjust his own work methods in a work station with scarce resources:

> *"Throughout the winter of the first deployment, I was unable to complete a number of repairs because the required parts were not available on station. Due to the isolation of Antarctica during the winter, spare parts could not arrive until the aircraft started flying south again...Two avenues, after you dealt with the frustration, of course, the fact that you can't fix something, you...start doing a bit of research to find out if there is anything else you have got in the station that will do the job. Like a particular transistor that might have a slightly different specification. By modifying the circuit a little bit, you might be able to make it work.*
>
> *The first year was very frustrating. Not realising of course that if I don't have the spares, there is a whole lot of stuff that is going to be hanging around until I did have the spares. I am used to fixing things as they went. Since then, I learnt a little of that sort of thing so that I know if it is not there, I just put it aside. I don't bother to think and wait for the arrival of the plane. It's been the same every year... After a while, the frustration disappeared. I accepted the fact down there.* ***This is the way it works. Then this is the way you have to work with it."*** [emphasis added] (T13)

The second theme comprises the ways to layer clothes. Ten out of 11 examples reported were from scientists who experienced a high chance of exposure to physical challenges in the outdoor conditions. Although taking safety precautions, such as proper layering of clothing, are emphasised in formal training, respondents may affirm or modify such knowledge on-site through situational, unintentional and experiential learning. Three respondents gave examples of this when describing a particular learning incident:

"...I don't think that registered until you know what they actually mean." (T5)

"Getting outside in cold environments rapidly makes you aware of the need to learn how to dress! If you don't learn this then you will be cold." (S7)

"...they were saying that you have to wear this, this, and this for this temperature. Finding a mix...but it was very much ***independently decided...****"* [emphasis added] (T8)

The majority of the respondents commented that it takes longer, or needs more effort, to carry out a task in I.C.E. conditions. Polar personnel appear to develop high awareness of their own physical limitations under such circumstances. The degree of exposure to isolated and extreme conditions depends on the work nature and workplace of polar personnel. For example, a domestic who works in a well-equipped, insulated, sheltered workplace like Scott Base may have easier access to the day-to-day necessities and comforts inside the station. In contrast, most scientists and field support personnel spent most of their time outdoors. Due to the extreme weather and the need to wear bulky clothing, more effort and patience are needed to complete a simple task. Good planning is, therefore, important before and during field deployment. Some polar personnel refer to this lesson as one of the Antarctic factors that a novice will learn in a field. Such learning is described by S7, below:

*"Getting outside in cold environments rapidly makes you aware...If you don't learn this then you will be cold...How it's done in Antarctica is knowing...What is possible? What are the problems? Like one of the Antarctic ways is that...****Everything takes longer****...So it's small job which would take you here 5 minutes...there takes half an hour...The other things are that it's* ***cold.*** *Here you don't have your gloves on and you have all the feeling in your hands. There you have to work with gloves.* ***Really complicated...****Then you wait till they are warm and start doing it again. That's the reason why it takes so much longer. Because in between the 5 minutes break, you just warm up your hands...go inside, warm yourself up and then work as long as you can stand."* [emphasis added] (S7)

Similar to task and social-related knowledge, 80 emotion-related examples reported are also related to I.C.E. conditions. Scientists reported a greater number and wider range of emotional examples (45) compared with the support personnel (35) (see Table 4).

The first theme suggests that emotional changes are contextualised; the incidents or events that one perceived in I.C.E. conditions may affect the person's emotions. An example of this is shown in S9's statement below:

> "...***excited, anxious, adrenaline-pumping and curiosity. Frequency and depth of these emotion changes varied with events, although unpleasantness could be felt slightly stronger and/or longer...****There's no knowledge on how to handle the emotions, just do it****..."*** [emphasis added] (S9)

These incidents or events may be associated with the physical, social, task or personal factors within a polar environment. When commenting about how her emotions were affected by the daily interactions with people at work, for example, S16 stated:

> *"...****a mix of feelings of freedom and claustrophobia on the Ice.*** *On one hand, you are in one of the most wild places we can ever expect to see in our lives, but on the other, you are extremely* ***dependent on your group and your work and free-time will be very much shaped by them.****"* (S16)

Factors outside a polar environment may also affect one's emotions. In the case of T11, it was the loss of a family member during a polar winter:

> *"...she got very sick probably a couple of months since the winter. The plane goes away for 7 months. And it was that time that she got very sick and passed away...It was ferocious and she only had a couple of months to live. So not being back here, being able to see with what was going on with the family, just saying certain things on the emails, certain things on the phone. Not being there to support one another, or even to be close to everyone...It was tough. It was tough. You know...I was quite sad."* (T11)

The second theme concerns the ways to manage one's own emotions by learning to be self-reliant psychologically. These include finding personal space, self-talk, psychological reconstructing self-identity or image, arranging not to be affected by others, and joking about a dangerous event that happened in a field. An example of how a novice learned to manage her emotions during the first deployment is shown in T5's statement:

> ***"Learning not to feel fully out of my depth*** *– during my first season I often* ***felt completely useless.*** *In other words, inexperienced, and this would* ***cause me to hesitate to do a lot of things.*** *As time progressed –* ***helped probably by learning a lot and the need to be a part of a team*** *and* ***just do the work,*** *I managed to* ***usually take the 'useless' feeling and put it more constructively into learning how to do a new task."*** [emphasis added] (T5)

Similarly, self-talk is evident in T10's statement:

> *"Mostly thinking about things that affect me and trying to identify what I am stressed out...talking yourself out of it. Trying to catch myself from negative self-talk...****Just changing my thought patterns, just sort of noticing that I was thinking negatively about a situation, trying to think about the positive."*** [emphasis added] (T10)

The majority of the respondents commented on strong, frequently fluctuating, intensified, and contextualised emotional swings in polar workplaces. "Open-minded" and "sensitive to others' needs" were frequently reported on a list of positive attributes. Two respondents provided examples of such emotional learning in their statements below:

> ***"In Scott Base and in field camps, the outside world can become considerably more remote from your existence.*** *The* ***outside world is not important any more. Your feelings and emotions become more concentrated. Small issues become large ones,*** *and when you get back home, you wonder why it annoyed you so much...****in a field camp the smallest, silliest things others do can be a major source of irritation.*** *So we* ***have to be aware of this and try to keep a perspective on things.*** *So the way someone brushes their hair, or where they always sit, or the way they ALWAYS say "howdy",* ***after 4 weeks of living with them can be so annoying****..."* [emphasis added] (S4)

"...the ***issues between my research team mates often led to conflict between them, which I found hard to deal with.*** *I am* ***not very used to dealing with personal conflict between people I don't know very well and I found it difficult emotionally to cope with.*** *I was very glad to have made* ***good friends with some of the others so that I could get a break.****..These realisations came to me from* ***being in that very close social environment, and [I] don't think I would have learnt this the same way in another setting."*** [emphasis added] (S16)

The majority of respondents reported a need to seek for, and to give others, personal space or time. When confronting a sense of prolonged confinement in Scott Base, for example, T11 stated:

"...often ***very hard to find your own space****...****I called it 'secret agenda' down there****...it's important to do all those sort of things...you have to go outside every day...even if it is walking around the front door, down outside the base and down to the back door.* ***You have to get outside every day."*** [emphasis added] (T11)

Emotional changes can be "amplified" by unfulfilled expectations after a prolonged deployment, as illustrated by two respondents below:

"In the middle of winter, ***all emotions are greatly amplified****... Small problems could get people a lot more upset than would be normal."* [emphasis added] (T17)

"…people reacted very differently if their expectations were unable to be met, either through weather influences or changing flight priorities (outside our sphere of influence). People reacted behaviourally from mild irritation through to crying and near hysteria. ***The level and depth of reaction varied according to gender, time spent on the Ice, and scale of their event.*** *For example, if a person had experienced 4-5 weeks of deep field science research they seemed better placed to respond compared to a person who had spent three to four weeks mostly associated with Scott Base."* [emphasis added] (T14)

Most of the 91 social-related examples reported are also associated with scarce resources. The first theme concerns the way to get along with others in small group conditions. This includes the techniques to treat others as individuals and to work in their terms, to arrange not to be affected by others psychologically, to accept and accommodate other's habits, lifestyles, personality, and to ignore them when necessary. When commenting about his social learning experience during a polar winter, for example, T7 reported a need to be socially sensitive, and to alter one's own perceptions in handling a social situation:

> *"Off the Ice, you can be a lot more direct with people...I guess you don't need to be as considerate of their feelings to get your point across. Whereas when you are living with them...**on the Ice...you got to be really, really careful and diplomatic about how you approach problems because you could very easily have found yourself alienated from the whole team and it would be a very lonely existence if that happened.** So it's the **self-preservation** thing, I might add."* [emphasis added] (T7)

A second theme involves the need and the means to share private and non-private physical spaces and facilities, such as rooms, tents and workplaces. In a recall of how she learned to manage a 'borderless' workplace and relationships, for example, S7 stated:

> *"...if you let somebody into your private [territory or space], you kind of committed something. Like you are giving something away and you are vulnerable. And you are in such a situation that you can't go back. Because you always have to live like that for the 15 months with each other. **So once you cross the boundaries, or you let someone too close to yourself, there is no going back. So the reaction was to keep people away, keep it at the professional level, don't talk about your feelings."*** [emphasis added] (S7)

The next theme concerns the needs and methods to be tolerant, or to appreciate individual differences or group diversity, such as age and profession gaps, especially during a prolonged deployment. An example is shown in S14's and T7's statements below:

"To avoid confrontation unless it was absolutely necessary...respect other people's views...it becomes obvious that you would enjoy yourself or you could have a miserable time by being argumentative, disagreeable or annoying...Don't talk about work immediately when you return to [the] camp – have a cup of tea and something to eat first..." (S14)

"I learnt that working and living with people so closely all of the time, you need to accept people's differences...because there were a lot of people from many different backgrounds here...By being open-minded and listening to what people had to say. My approach to this would have been different off the Ice because I would probably not have socialized with these people back home." (T7)

The fourth theme concerns the need and approaches to seek social, personal or psychological space within, or outside of, a constructed or social environment. Respondents reported that as the largest and most well-equipped Antarctic station, and situated just three kilometres away from Scott Base, McMurdo Station offers an easy access for Scott Base personnel to be away from work, social or psychological tension, if and when needed (T8 and T13). Personnel from both stations can visit each other by foot, bike, shuttle bus or other vehicles. By exploring alternative spaces, for example, T8 was able to alter his mindset during a deployment:

"I often get away to McMurdo, just a room of my own...where I...sit down and watch American TV, reading American books, just to get away from Scott Base and things like that. And then come back...much fresher when dealing with things." (T8)

The last theme is largely associated with small group attributes that can be classified in four ways. The first way deals with the development and dynamics of informal groups based on individuals' work and social roles, different types of interpersonal relationships, as well as being the minority in a crew. With a sense of being the least experienced in her crew, for example, T5 learned to modify her self-perception, social roles and behaviours in order to fit into the group:

"Because everyone was quite good at what they do down there, so you have to find something that you were good at. So it was ***more of a necessity****... **I don't think about that**... I went down...didn't really having the experience...**I did feel a bit useless...**I didn't want to*

be there and do that [being the least experienced] and that ***was probably a very quick realisation from the beginning that this is my position in the group.*** *I just don't like to being seen as a little girl, silly little girl…I guess it's partly the* ***male and the female*** *thing. And probably the* ***age****…in front of a group with men****...I'll behave a lot more seriously.***

Because I don't want them to see me as silly...

I learnt quickly to 'harden' up about a lot of things. Working with experienced males to maintain your position as useful in a group – I felt as a woman I needed to be able to do most things...carrying gear, harnessing. ***Interaction seems to be very based on a respect of usefulness – especially in the field.*** *You are there to do a job and laziness or complaints are not tolerated."* [emphasis added] (T5)

Seven respondents reported that friendships appear to develop faster or deeper in I.C.E. conditions. For example, S1 said:

"I think the friendships are developed ***more quickly and more intensely on the Ice because you are sharing a much more extreme environment and you have no escape****...you are thrown together and you got to make the most of that."* [emphasis added] (S1)

Most respondents reported an interrelationship among task, emotional and social-related knowledge. For example, in a review of how a social relationship affected him at work, S4 stated:

"*Scientists are generally very focussed on getting the science done and often spend very long hours working. We have only the one opportunity to do the work in a year – we won't be back until next year and we only have these few weeks to get our work done.* ***So there is little time for social interaction with others apart from the necessary work related interactions****...****it was (and still is) important to socialise with others there.*** *I took particular time to be friendly with those base staff that I really needed! I spent time listening to their stories and gripes and grizzles hoping that they might be more helpful later when I needed them! Cynical? I don't think so.* ***An important aspect of getting on with people and ensuring the work gets done."*** [emphasis added] (S4)

Similarly, socialisation is perceived as crucial for the development of a cohesive group, so much so that T13 modified his social behaviours during a polar winter in order to be perceived as part of an informal group:

> *"...shortly after winter started, they noticed that I hadn't been joining all the social events...*
>
> *I changed my way of doing things during the winter than what it was like during the summer. I just turned up in a few of these social events. I didn't stay for the whole thing. It helped if you appear in the events, break events down, and clean up afterward. Just your head in the door once every half an hour or so. They are quite happy with it. They see your face and you are joining in."* (T13)

When asking about the first deployment, it became clear that socialization would need to be considered. This is because socialization is generally viewed as being anchored to a specific social group. However, the participants volunteered descriptions of prior social knowledge derived from other contexts. This allowed a broadening of the results and indicated that context-specific socialization procedures were of less importance than initially thought. These other contexts ranged from flatting, parenting, marriage, and other conventional environments, to I.C.E. workplaces, such as military, alpine areas, places with the absence of a 24-hour day, and those with a thin boundary between work and non-work. Most of these learning conditions were characterized by close proximity and, sometimes, intense social interaction. More of these findings will be discussed later in Section 3.4, *Disparities as Drivers of Learning*, below.

Learning Processes Reported

Learning experiences of the respondents can be classified into three levels of conscious awareness. At the first level, respondents were more descriptive about learning content compared with the process to learn the content. A typical example involves extensive descriptions of a learning content by one of the respondents, and a simple statement of the learning process as such by the same person: "observation of others, reflection" (S10).

At the second level, respondents were ready to explain how the initial learnt content may affect a subsequent learning situation during the first deployment. Based on the types of learning transfer proposed by Schunk (2008), this level involves a *near transfer of learning* between similar contexts. When describing how he learnt to carry out a science experiment after numerous trials during his first deployment, for example, S1 stated:

> *"...we had one instance where we set up an experiment. The weather changed and it blew out in the sea ice and we lost our experiment!... and you remember other instances where we learnt by experience...observe things that went wrong, look around to see the resources, improve the methods, using the resources..."* (S1)

Similarly, the task learning experience of one of the respondents was affected by her sense of insecurity and anxiety during the early stage of her first deployment:

> *"I got better at dealing with the age difference between me and my colleagues. At the* ***beginning of the trip, I was very conscious of my age and felt young and less experienced than*** *the others, which made me* ***a bit less open and friendly than I usually am in a social setting. By the end of the trip I felt a lot less aware of the age difference.****"* [emphasis added] (S16)

Similarly, when describing how the "first set of circumstances" of his emotional learning affected his subsequent learning approach, T2 commented on how his feeling made him become more aware of such learning transfer:

> *"I felt myself getting quite self-conscious about other people getting bored of my company or fearing that they were irritated by me on my shift because on some days there was not the same feeling of positive rapport between me and my co-workers. After a while, I realised that actually there was no problem and that in fact I was getting irritated and bored by them. I learned this through observing my co-workers and then by reflection later on in the day when I was on my own. I was not aware I had learned this during the first set of circumstances, it was not until afterwards when I was reflecting on my feelings that I realised it."* (T2)

The third level is characterised by an individual's awareness and capability to compare and contrast their learning experiences across comparatively dissimilar contexts, namely a *far transfer of learning* (Schunk, 2008). These respondents appear to be aware of the use of their past learning principles and mental models for subsequent learning. When reviewing his learning approaches across polar seasons, T13 provided such an example in his statement, below:

> *"Every season is unique. The circumstance is unique. The resolution of the problems is normally the same. I guess what I am trying to say there is that the unique set of circumstances may cause something to happen, but the way to fix it is to use the way that you used to fix another circumstance...it's something that was learnt over the years.* ***It might look different to start with, but the time that you break it down into compartments, it's exactly as it was the last time...*** *the whole of my learning processes just sort of compartmentalised. It's in the main computer."* [emphasis added] (T13)

In most cases, prompts were needed during an interview to initiate detailed discussion of learning processes. As a result, more prompts were incorporated into the questionnaire during the early stage of data collection in order to solicit relevant data. Despite that, details of the learning process were still more commonly provided during the follow-up interviews. This indicates that although implicit learning processes may be the mechanisms that lead to a learning outcome, they often take a 'backseat' role in the conscious mind of an individual.

The following sections present the major findings regarding learning processes. The first section demonstrates the nature of implicit learning and associated learning methods. The second part presents the learning resources, cues and needs that facilitate the acquisition, utilisation and transfer of implicit learning. These include temporal, emotional and other individual factors such as the impacts of context intensity and learning intensity on implicit learning.

Nature of Implicit Learning and Methods

Most of the implicit learning reported is unintentional, situational and/or experiential. Although a dual-learning process may take place when a learning resource is available, most learning experiences begin with implicit learning. The following statements highlight such a situation:

"…that's something when the initial thing was happening, it wasn't conscious. But I was trying to explain things to myself later or reflecting on it" (T6)

"…in those [social] situations...sometimes I feel the tension…trial and error...after that I started to read books about communication..." (S11)

Task, emotional and social learning seem to be an interrelated, cyclic, non-linear, dynamic and *contextually sensitive* process that may develop from a past experience. Respondents in a prolonged isolated and confined condition (i.e., small group and scarce resources) may have more opportunities for exposure to similar contexts and people. As a result, they have the chance to work on their learning approaches for a longer period. In turn, they become more contextually sensitive towards a learning cue within a learning environment. This example is evident with T8 who commented that although a guidebook on how to work with the American and Italian Antarctic personnel was given to him before a deployment, extensive time was spent during a polar winter to learn and "fine-tune" his social learning approaches:

"...when the population drops down...[polar personnel] talked...sitting down at the table and listened to what they are talking about. How they are dealing with each other... ***more long term down*** *there...You got to* ***work on your approach for a much longer period so that the approach might be working to a point, and you actually got to deviate and change and teach yourself with some new learning cause that person is changed, too and situation changed...Tailored your conversation."*** [emphasis added] (T8)

Common learning methods reported include: observation of a phenomenon such as place, event and people; deduction from past experience; trial-and-error; self-reflection; talking and listening to others; and reading. Non-implicit learning reported includes training and meetings. In most cases, more than a learning method was used to acquire a learning content. Overall, task and social learning appears to involve observation. Individuals are more likely to use trial-and-error and talking to others after they have assessed the consequences of doing so. That is, if a learning incident involves a concern for safety, or it is socially sensitive to talk to others, an individual may not 'try his or her luck' with trial-and-error. Deduction from experience seems to be the most frequently used method in learning task, emotional and social knowledge.

Self-reflection is often used to review one's own self and learning approach after a learning event. Such reflection may vary by degree, from simple to complex reflection. Since complex reflection may require sufficient time for it to take effect, it is more likely to take place after the occurrence of an initial incident. In some cases, it may take years before an individual becomes aware of such an experience. This is evident in S8's statement:

> *"...I wasn't aware that I had learned how to shut off my emotions from her. It felt like a* ***natural process at the time and I am only aware of it while writing this questionnaire****."* [emphasis added] (S8)

Although learning content, sequences and methods used may vary across contexts, most respondents reported the use of previous learning experiences, in particular learning principles and mental models for polar learning. Individuals seemed to experience a lower degree of awareness during the initial stage of this learning:

> *"...Probably something that I thought about inside, reflected on it and thought about why is it that I would do that there and not here and so* ***it's not something that I probably realised at the time."*** [emphasis added] (T6)

Such awareness may increase if, and when, the learning approach used leads to an observable, positive and pragmatic result at the earlier stage. Such an example is made apparent by T1 who compared and contrasted her learning approaches at a polar and a conventional workplace:

> *"I guess the biggest difference would be back home I wouldn't be so aware that I was learning it, I would simply be watching them and learning unconsciously, whereas watching my amphipods in Antarctica, I was aware that everything I saw would be valuable to me later on."* (T1)

3.4 Disparities as Drivers of Learning

In general, the interplay between a learner's perceptions and interpretations of a learning experience and a learning environment reinforces knowledge acquisition or learning transfer. This section divides the disparities that serve as the drivers of learning into three types: learning transfer, learning environment and learner factors.

The first part of this section presents the common themes about learning transfer. By and large, the variation of learning content and process reported earlier in this chapter seem to be associated with a learning gap between an 'original context' and a 'transfer context'. The term 'original context' refers to the initial occurrence of a learning incident as perceived by a learner, rather than an initial learning incident that can be objectively observed or verified by a third party.

This is followed by a discussion of the disparities of learning environments as the drivers of learning. In particular, the perceptions of isolated, confined and extreme conditions, small group attributes, as well as the border between work and non-work issues will be presented. The deprivation of privacy and scarce resources in a polar workplace seem to serve as the drivers of learning in I.C.E. conditions.

The last part of this section presents how the disparities of a learner affect the drivers of learning. These include individuals' disparities of perception and sense of unusualness, time, learning cues and intensity, as well as emotion associated with implicit learning. The degree to which an individual adjusts his or her perceptions may be influenced by a similar, but not necessarily identical, prior experience. This may explain how what is perceived as unusual by a respondent may change with exposure to similar contexts. Likewise, what is perceived as 'unusual' by one respondent may not be perceived as unusual by another.

3.4.1 Learning Transfer

In general, learning may be triggered by 'push factors' and/or 'pull factors' perceived by an individual. Learning occurs when there is a *perceived learning need* to close a *learning gap* between two conditions. These learning gaps may include, but are not limited to, the following categories.

The first category is the *learning environment gap*. This refers to a discrepancy amongst the learning environmental factors from the past, current or ideal/future aspects. The term 'learning environment' rather than 'learning context or situation' is used to represent physical-technical-organisational (P-T-O) and social-cultural (S-C) learning conditions. This includes factors such as place, people, process and time of a learning event. A gap in learning may be reported by an

individual when he or she detects an identical, or non-identical, factor in between a 'past' and a 'present' learning situation. This perceived gap may then affect the types of task, emotional and social learning content to be acquired. Subsequently, depending on the types and complexity of learning content to be acquired, as well as the learning resources available, an individual's past learning experience may serve as a base for new learning needs. In general, a learning gap between an 'original context' and a 'transfer context' seems to result in a variation in the learning content and process reported.

The second type is *learning content or knowledge gap.* This gap refers to a discrepancy of knowledge amongst past, current or ideal/future knowledge needed to function in a particular context. The third type, *the learning process gap*, concerns a discrepancy amongst past, current or ideal/future learning approach needed to function in a particular context. This is followed by identity, self-image and personality gap – a discrepancy amongst a past, current or ideal/future self. The last type, emotion gap, relates to a discrepancy among a past, current or ideal/future emotion associated with a learning mechanism.

Some learning needs appear to be consciously reinforced by a wide range of motives. Other learning has less conscious needs or acts to close the learning gaps between two contexts, in particular, during the "initial stage" of learning. These needs appear to initiate the transfer of learning from one context to another. In general, respondents in this study are in two groups with respect to the transfer of a learning experience (see Figure 14).

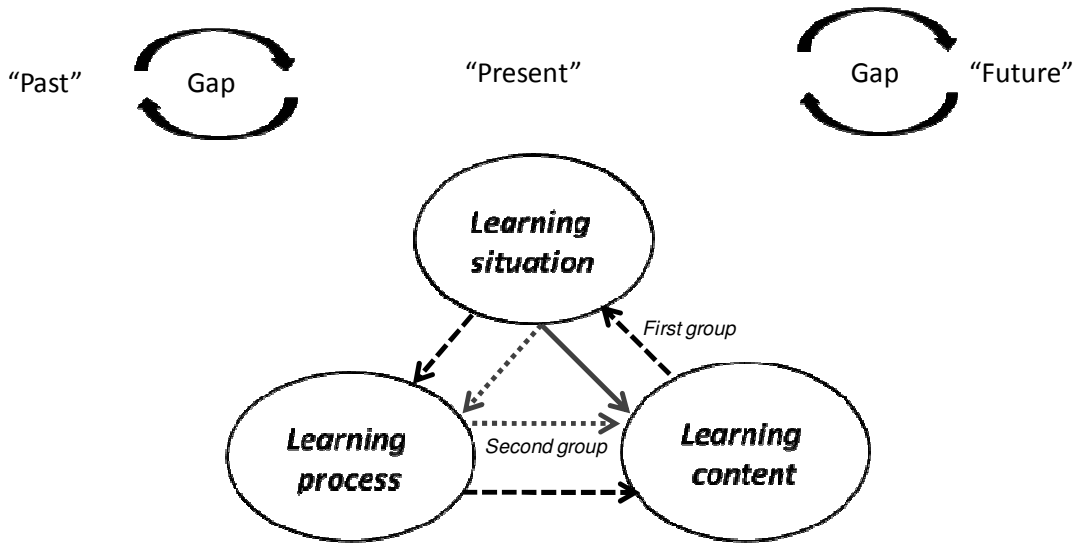


Figure 14: Proposed Learning Transfer Model for People on Polar Deployment

The first group focused on the transfer of a learning process, method, principle and mental model used across polar and non-polar contexts (the outer line in Figure 14). This cohort credits the transfer of a similar learning principle and mental model across learning environments to the factors associated with a learner, such as personality, identity, or other identical elements across learning environments. Most of these realisations transpired through either a complex reflection or double loop learning (Argyris & Schon, 1974) after an incident.

The second group focused on the transfer of learning content (the inner line in Figure 14). These respondents reported that learning content is less likely to transfer across polar and non-polar contexts. Upon further investigation during the interviews, some respondents from this group often shifted their foci to a learning process, method, principle or mental model used. When this occurred, they often reported similar comments to those from the first cohort. In other words, this group of respondents was more content-oriented (with a focus on learning content) rather than process-oriented (with a focus on learning process) during the early stage of learning.

These findings are embedded in the Revised Adaptive Implicit Learning Model for People on Polar Deployment (Figure 13).

3.4.2 Disparities of Learning Environments

Disparities in learning environments may serve as drivers of learning. In particular, the perceptions of isolated, confined and extreme conditions, small group attributes, as well as the border between work and non-work, will be discussed in the following sections. The deprivation of privacy and scarce resources in a polar workplace appear to reinforce implicit learning in I.C.E. conditions.

Isolation, Confinement and Extremeness (I.C.E.)

As mentioned in Chapter 2, the term 'polar learning environment' is defined here as a combination of physical, organisational and social-cultural elements that formed the working and living space and climate for learning in a polar region. As a general rule, a high degree of I.C.E., brought about by such factors as a small crew size and relatively homogeneous composition of crew, appears to affect the social dynamics and the types and level of social activities during a polar deployment. These restricted social circles or activities tend to provide and trigger the opportunities and needs for certain types of task, emotional and social learning. The intensity in a polar context, therefore, creates demands for learning to take place. In order to function within the I.C.E. conditions, polar personnel acquired these types of knowledge from, and for, day-to-day activities by using the resources and cues in a learning environment for their learning needs. Most of these findings were presented earlier in this chapter in the statements related to learning content and learning processes.

The following section discusses the degree of I.C.E. environments perceived by the respondents and the implications for knowledge acquisition and transfer.

Two types of environment appear to highlight the nature of working and living in these regions. Natural environments are characterised by high altitude, extreme climate, atmospheric conditions and scarce resources. Constructed environments, such as research stations, field sites and vessels, are characterised by small community, confined space and social life. Some respondents associated the degree of I.C.E. with the working and living conditions, such as space, demands and facilities. Others related that to social issues in small group conditions.

The first theme is associated with the perceptions and interpretations of isolated and extreme working and living conditions. 'Extremeness' is often defined as the degree of life threatening conditions in polar environments (Suedfeld, 1987; Palinkas, 2000, 2003). The common life threatening conditions reported by the respondents (S11, T7, and T8) included: 1) the natural

hazards such as whiteout, blizzards, weather conditions, crevasses and thin ice shelf; and 2) the human defaults such as unsafe human acts and faulty vehicles. The following section compares and contrasts the degree of isolation and extremeness of the research station(s), field sites and vessels perceived by the respondents.

Basically, a remote field site is considered a more isolated and extreme place because of its exposure to natural hazards and limited support from the 'outside world' compared with a common field site, research vessel or station. According to some respondents, the degree of remoteness on a vessel, in terms of the facilities, resources, support, safety and capacity of occupants, seemed to be similar to those of a research station; for example, as at a station, meals are provided by the professional chefs to the occupants. Therefore, the work and social routine on a vessel seemed to be relatively more structured and comfortable compared with the work and social routine in the field. Likewise, 24-hour work shifts and natural environment appear to affect human activities on a vessel in polar waters.

In reflecting on her polar deployments, for example, S12 commented that learning in a deep (remote) field was a more challenging experience, than in other polar workplaces:

> *"Leading my first deep field party was a definite learning curve that was very different to my two earlier trips."* (S12)

According to some respondents, the exposure to isolated and extreme conditions seemed to depend on the nature of the work and the workplace of polar personnel. Most scientists and only a handful of support personnel worked at field sites during the summer. They spend less time at the research station, usually at the beginning and the end of their field trips. Before their field deployment, personnel sort out the logistic and manpower arrangement, science equipment, field supply, transport, take Antarctic Field Training, obtain a license to drive polar vehicles and then wait for suitable weather to go to their selected fields and set up their tents. Due to the increasing practice of sharing facilities with different field parties, a camp manager may be assigned to coordinate work at a field camp. He may be supported by support personnel from Antarctic New Zealand and/or other organisations.

Due to the nature of their work, most scientists in this study work longer in outdoor conditions under the 24 hours daylight of summer. Unlike those at the stations, these personnel have to put up their own tents, kitchens, toilets, work stations and cook meals for their crew

working with limited time and scarce resources with 2 to 40 crew members. They also have to watch out for physical hazards and for the safety of the whole crew when making decisions at the field site.

For support personnel who work in well-equipped, insulated, sheltered workplaces, such as Scott Base, easier access to the day-to-day necessities inside the station offers a degree of comfort comparable to that of a conventional workplace. As a result of these work conditions, Scott Base is viewed by some respondents as an "*isolated...[but] a really safe and controlled environment to be working in.*" (T8). When comparing learning between a polar environment and a conventional workplace, for example, T7 commented:

> *"...it is* ***not so critical*** *at home to get everything* ***as accurate as*** *possible. H****ere it can be life and death if something goes wrong, so the approach was to learn as much as possible."*** [emphasis added] (T7)

In addition to the above, the sense of isolation and confinement may be associated with social and psychological tensions in a small group. This may happen when polar personnel need to find a balance between personal feelings and a dependency on each other for their safety and their desire to achieve the mission's aims. According to eight respondents, due to the lack of separation from a context and people, a physically, mentally and psychologically exhausted individual who worked continuously with an empty stomach in cold weather may be more emotionally and socially distressed. One of the respondents gave an example of this in her statement:

> *"Working in ice core drilling and deep in the field requires a* ***dependence on weather that some larger camps don't have quite so much.*** *Hence, when we could – people were working* ***long nights, and often switching between day/night works.*** *As the least technically experienced there, I* ***learnt very rapidly*** *that people* ***required large hot meals, at multiple times during the day and wouldn't often ask for them****, rather [they] work too hard and then crash."* [emphasis added] (T5)

In most cases reported, individuals do not always have the opportunity to walk away from a stressful circumstance in order to 'chill out' in a polar environment. Therefore, they have to alter or contain their emotions until such time they are in a different environment. In most cases, this

opportunity may occur after the deployment. These social and emotional tensions often involved a conflict of interests between people, such as in the incident described by S11:

> *"...we were in the field...problem with the GPS [Global Positioning System] equipment...I strongly urged to go back to the base and to bring back equipment in order to get on with the measurement...scientific leader accusing me, saying that I only would like to go back to the base because I cannot stand the cold....because of* ***the tricky situation*** *in the fog, there was* ***little time*** *to discuss about that, so we were* ***sticking together****...the weather improved, that was the moment, and I just stopped and said...It was after a couple of hours..."OK. Stop!". I put everything on the Ice and I started to explain to him every bit of the equipment, what's it good for...He was standing there...listening...I would say that it's a situation* ***with very high tension between two of us in the middle of nowhere. We rely on each other in the situation. Nevertheless, we have intense conflicts about the procedure, about the equipment that we are having with us.***
>
> ***On the Ice, everything is just life dependent. Whatever you do...if anything goes wrong, you are just isolated. It's hard to get help...****Communication, especially at that time, was restricted... So we were just alone...* ***that's extreme situation****.*
>
> *If you go to the field as a responsible person, you have the responsibility of the safety of the others.* ***So you are limited in what you can do, so you are stressed sometime. Safety.***
>
> ***It takes a lot of effort to go to the field*** *in terms of preparation, logistics, money...Once I am there, I tried to take the chance to measure...to do anything that I can do to take those measurements, to bring it home. To make something out of it.* ***One never knows if it is possible to come back again****."* [emphasis added] (S11)

The perceptions and interpretations of isolation and confinement may also alter individuals' adjustment during their deployment. Due to the extreme natural environment, constructed environments, such as research stations, field sites and vessels, are designed to accommodate human needs in polar regions. The physical layout, difficulty in obtaining resources, and degree of restriction in physical, social and personal space in this environment may affect

individuals' perceptions of isolation and confinement. According to some respondents, due to the lack of resources, such as support and tools, individuals may experience a sense of isolation and confinement during a deployment. In particular, this was found among those respondents in prolonged deployment. A wide range of adaptation behaviours may be learned, including a need to be self-reliant and to modify work methods and techniques in the field, as illustrated by S7's statement:

> *"Because you have **limited supplies.** You have limited ways of **information,** you have **limited logistics.** If you are here [conventional environment]...get customer service. And there is no customer service there [polar environment]...**So there is simply not the surrounding, the networks, the supports like normal places.**.."* [emphasis added] (S7)

Small Group Attributes

In addition to physical environments, social environments in polar workplace also create a demand for implicit learning. This section describes the small group attributes reported.

On the whole, informal social groups may be formed before or throughout a polar deployment. Most Scott Base personnel, and a handful of personnel who know each other, may form informal groups before a polar deployment. Others may meet for the first time during their deployment. During the early stage of deployment, most personnel focus on the task that they are deployed to do, before diverting their attention to other social and emotion-related issues. This is evident in T12's statement:

> *"**When you first arrived, everyone was very focused on their own individual jobs**. Most of the people I knew, they were settling in and figuring out where everything is and then you own working environment. You are just doing the jobs that you have done a thousands of times before, but you are in a new space and you get a bit hang of it. You got to assign to the machines..., get driving lesson...trucks and forklifts and all sorts...you got to be ready for the layout of where everything is. Then you go across to McMurdo to meet the people there that you are going to be dealing with and know where... You very very focused on the work individually while you are doing what you need to do to achieve the job.*

And then slowly**, once you start to get into the morning meeting and all that, with different units come together and talk about what they will be doing in a day, you start to see how everybody is working together toward the same goals. And there was 35 core base staff that work there that summer to provide the support for the scientists. So everything you do is for the one goal. It's always interesting how things working or don't work, and personality **i**s the probably biggest thing that comes into that...when you are in a **team environment...If you change something in the mix where everything else is affected and all other people are affected because it's a small group... Because you are very aware of what stage everybody else is in and how they are and how they are feeling...You are more sensitive. Emotionally." [emphasis added] (T12)

Usually only one or a handful of personnel is deployed in each occupation per season. The role and routine of work among these personnel may reinforce the development of social relationships with their work- or room-mates. This is evident in T1's statement:

"*Most of the crew and scientists were split up into two shifts – midnight to midday and midday to midnight. However, my team of five (the pelagic team) were on no particular timetable. That means my team had interactions with everyone on board, rather than just half the people.*" (T1)

Non-work cliques may form, depending on the length of deployment and the sense of belonging that individuals may develop in a particular social environment. According to some respondents, informal groups may form based on the characteristics of a crew. The first feature is by occupational groups, such as support personnel and scientists, or military and civilian. The second way is by personal interests, such as indoor and outdoor activities, social events and those who look for solitude. The next method is by polar experience, such as old hands and novices, or winter and summer crew. A group may also be formed by their nationality, such as New Zealanders and Americans, as well as other individual factors, such as age, sex and personality. These examples are evident in the paragraphs and quotes given by the respondents below.

Apart from work schedule, mealtime appears to be the next most frequently reported factor that reinforces the development of informal groups. As meals are served by professional chefs at Scott Base and on a vessel, work schedules are often arranged around the scheduled

meals. Conversely, meals are arranged around the progress of work in the field while the cooking duties are usually shared among polar personnel, according to some respondents. When describing his experience forming an informal group, for example, S1 stated:

> *"Well that's something [scheduled meals] that you have no control of. If you want to be fed in Scott Base, for example, you have to turn up at that time..."* (S1)

Some respondents formed informal groups during recreation activities, such as during parties (Christmas, midwinter and 'get-to-know-each-other-and-the-environment'), music bands, movies, field trips and other formal events. Informal relationships are said to be formed more easily outside of work because individuals may feel more at ease in such circumstances compared with when they are at work. According to some respondents, socialisation outside of work appears to be critical for work-related relationships. When describing his experience in forming informal groups, for example, S13 pointed out that individuals who experience difficulty in adjusting socially, may be perceived as 'outsiders':

> *"Social activities after shift work are important in developing team bonds. Those that didn't participate were seen a bit as* ***outsiders****."* [emphasis added] (S13)

Group dynamics within the same crew may change from summer to winter. As the crew size changed significantly during the winter, more intense personal relationships may develop among the winter community. T13 gave an example of this when describing a social learning event:

> *"In the summer...more like a sort of wild party type thing...The places are too hectic. During the winter, it sort of becomes a different social atmosphere...[polar personnel] form their own sort of peer groups..."* (T13)

Some of these intense relationships turn out to be positive, others go sour. Unlike in conventional environments, individuals may not have the option of walking away from an uncomfortable situation in a polar workplace. Although the composition of crew and personality may influence individuals' adaptation to such a social environment, some respondents questioned

the challenge of putting together a socially functional crew through polar selection. This is evident in T12's statement:

> *"...**personality is probably the biggest thing...**They [Antarctic New Zealand] have spent a lot of time working with people [Scott Base support personnel] before they go down there, decide what the dynamic are, **except the military people.** So perhaps that 35 positions, maybe seven or nine people aren't looked at and put through a psychological test, the personality test.*
>
> ***They just automatically presumed they will handle it and they will be fine when you are in a team environment, they will slot them straight in. Whereas all the other staff have to go through all that.**..How are you going to know if they [military personnel] might work with each other...in **that type of environment**. **Personality wise, how they are going to gel with the civilian staff. There is a little bit of the 'us' and 'them'.** 'Ah you are the military people.'"* [emphasis added] (T12)

Depending on the composition of a crew, dominant and minority groups are formed differently across seasons. This includes social congregation and segregation based on sex, occupation and polar experience, as illustrated by T12 below:

> *"It's **like boys and girls in a room**. Boys, for some reason, they will congregate together. And girls will be over there doing something else**. It's just way where it splits sometimes.***
>
> *Probably, definitely socialising...groups formed...I saw it personally that people that were very pro-military, if you like, they have never done anything, being away anywhere outside of the military, they have never work with civilian ever and **military people are different in the way that they behave and in the way that they think.** Come into a group thing.*
>
> *Hm. I definitely picked up some comments being made because there have been problems in the past with the military people I think. The integration and I think there have been instances with alcohol and all that sort of stuff that perhaps give the group a bad name and expectation that it could be troubles. That sort of attitude that goes on**. But it's certainly***

not something that you go there and thinking about. It's when you get down there and the conversation started to happening with the staff who worked there for the last 5 years *and they said blah blah blah we have troubles... such as such last year."* [emphasis added] (T12)

Some respondents reported how social norms and unwritten rules were developed during the formation of informal groups. An example of this is given by T12 in her statement below:

"During the first week. Naturally they start to ***decide on who they are getting with, who they want to spend time with socially, and the one that they just wanted to be acquaintances****. You know all the normal kind of things that happened. I suppose the people that you work with closely formed a stronger relationship with you, good or bad. It might be those that developed in the work environment. Perhaps they are not hanging out socially, but they are spending a lot of time socially. Perhaps during quiet time, you are at the library one o-clock in the morning, other* ***like-minded people*** *are sitting there with their coffee as well rather than sitting in the bar."* [emphasis added] (T12)

Some of these social norms might be transferred from other environments, others are created *in situ*. Although these social norms are often unknown to the outsiders or novices in that social environment, these unwritten social norms serve as learning cues to reinforce task, emotional and social learning among these outsiders. When describing an unwritten rule about taking off one's hat in the bar at Scott Base, for example, T6 pointed out how an insider may be used by an outsider as a source of learning in this social context:

"...those sort of unwritten rules about the bar...not just realising that that was the rules but realising that 'Oh! People reacted quite strongly to that.' The ***insiders*** *who were already there...because* ***we were all new and we were relying on someone making some of the mistakes...****then I would learn from somebody else's mistakes..."* [emphasis added] (T6)

Due to seasonal deployment, implicit learning of social norms appears to be an on-going process. These norms may include the dos and don'ts, such as to helping out with work at the base, such as dish-washing, and not to cross the boundary of work and non-work relationships. When describing how having privacy is a luxury at Scott Base, for example, T13 commented:

> *"It's very hard to keep a secret down here. You are doing something that you want to keep quiet. You can just about guarantee within a month everybody in the station will know it. Because the wall has ears and the spies are everywhere. It may develop from hearsay initially."* (T13)

In some cases, 'socially unacceptable' romantic relationships developed in a polar environment may be kept from "outside world" by the code of "what happens on the Ice, stays on Ice", according to some respondents. This example is evident in T13's statement:

> *"It's like the boy scouts code I suppose. It's mostly accepted that what happened down here, it stays down here, except there have been instances where other people have been upset by certain relationships and pass the relationships to the outside world."* (T13)

One of the most common findings among the respondents is individuals' needs and approaches to gaining membership into an informal group, especially during the winter. Due to the importance of being socially accepted by other crew members in I.C.E. environments, individuals may sense a need to adjust their social behaviour accordingly in order to 'fit in', in particular, if they are the minority in a crew. One of the respondents provided an example of this small group attribute during polar winters in his statement:

> *"...every single year, there was one person that was pretty much a universal outcast by the end of the winter. They were still tolerated, and treated with civility, but were a regular topic of conversation and condescension when they were not present."* (T14)

Consequently, a wide range of social behaviour was reported, ranging from forming alliances, finding a social or work role in order to fit into a crew, modifying one's own behaviour, perceptions and interpretations of a social or work situation, to demonstrating one's contribution and sensitive to others' needs.

Being the only female in a male-dominated crew, for example, T6 commented:

> *"I was the odd one out...in order to feel comfortable with the group and to be able to contribute to it,* ***I needed to fit in*** *to a certain extent. I wasn't going to change my gender...instance like somebody told a joke that seemed sexist or whatever, then I couldn't get offended about it... sometimes I laughed along with everybody else and sometimes I just don't say nothing...* ***So that you will be part of the group and people don't need to feel the need to change their behaviours just because you are in the room.*** *I didn't want special treatment.*
>
> *Like if there is a group of 10 people and they are all drinking beer, I would have beer. I would not try to get a glass of wine* ***because it's better to try to fit in...It's just sort of symbolic thing I guess.*** *Like it doesn't turn me in to one of the group, but it means that I am not trying to make myself different."* [emphasis added] (T6)

Similarly, when describing how she, a novice, behaved a lot more seriously in front of the old hands, T5 commented:

> *"Because everyone was quite good at what they do down there, so you have to find something that you were good at. So it was* ***more of a necessity****...****I don't think about that****...I went down... didn't really having the experience...****I did feel a bit useless...****I didn't want to be there and do that [i.e., being the least experienced in the group] and that* ***was probably a very quick realisation from the beginning that this is my position in the group.*** *I just don't like to being seen as a little girl, silly little girl…I guess it's partly the* ***male and the female*** *thing. And probably the* ***age****…in front of a group with men****...I'll behave a lot more seriously.*** *Because I don't want them to see me as silly..."* [emphasis added] (T5)

Another example is given in T11's comment below:

> *"...if I knew that I am going to be wintering over, I would probably make more effort to invest more time to get to know other people who are going to be wintering over and establish the [social relationships with them]..."* (T11)

According to nine respondents, a person who is self-reliant and sensitive to others' needs portrays a positive self-image that may make it easier for him or her to gain the acceptance of others in an I.C.E. workplace. For example, when describing the need to be more sensitive socially and alter his perceptions in handling a social situation, T7 commented:

> *"Off the Ice, you can be a lot more direct with people...I guess you don't need to be as considerate of their feelings to get your point across. Whereas when you are living with them...**on the Ice...you got to be really, really careful and diplomatic about how you approach problems because you could very easy find yourself alienated from the whole team and it would be a very lonely existence if that happened.** So it's the **self-preservation** thing, I might add."* [emphasis added] (T7)

However, the awareness of these driving forces or social behaviours might not always be initially obvious to an individual. This is evident in T6's statement below:

> *"...being the only woman in the group [polar environment]...on reflection, I mean this is something like thinking it through later, I think I ended up making sort of strong alliance with one, or often one or two people...to make my position really clear, so that I wasn't sort of being available to the whole group...it was subconsciously, something like that...I don't know...When I looked back, I think "Really? Did I really think like that?" It happened like more than once [in subsequent polar deployments]..."* (T6)

Attention, ownership and the intentionality of such learning may increase if one is exposed regularly to such conditions. Most of the personnel reported the use of experience as a base to deal with these small group attributes. These experiences may or may not be directly related to polar deployment. Some respondents learnt their social skills from flatting, parenting, marriage,

conventional and other I.C.E. workplaces, such as military, alpine and places with the absence of a 24-hour day. Most of these learning conditions were characterised by close proximity and sometimes intense contacts with people socially. The learning conditions in polar regions are said to be more intense due to one's lack of separation from a learning environment. In an attempt to apply role modelling in an interpersonal relationship in polar workplace, for example, T7 stated:

> *"I think I learnt it [role model] by raising children...to do and learn from what they see, actions speak louder than words.* ***So I think being a parent taught me to do that. But I think that I did it more throughout on the Ice because I was in the eye of everybody pretty much all the time.*** *Whereas as parent, kids will go to school or I will go to work. At night, they will be in bed or whatever.* ***I didn't have the same amount of contact****."* [emphasis added] (T7)

In some cases, respondents had to work with the same crew members in different deployments. Although the interval between polar deployments may help to reduce any unresolved social tensions from the previous deployment, these respondents reported similar cues, in terms of personality traits and environment, that might still trigger interpersonal conflicts in the subsequent deployment.

As some polar personnel may work or socialise in same professional circles, they are concerned about how their social behaviours during a deployment may be perceived by others *in situ*, as well as those outside the polar environment, such as off-Ice Antarctic community. Apart from Antarctica New Zealand and military personnel, selection of other polar personnel appears to rely on subjective judgements, such as interviews, social networks and word-of-mouth within the Antarctic community. Therefore, modification of social behaviours may be a pragmatic act reinforced by factors beyond a polar environment, such as a concern for one's future polar career. T5 provided such example in her statement:

*"I was more careful about my interaction with people on my second trip simply as I realised the **smallness of the Antarctic community**, and if you want to stay in the field – your reputation as a responsible, mature adult in <u>all</u> situations – socialising or work, is important. There are not many situations where you live fully – including socialising at your workplace and hence it's difficult to separate the two."* [emphasis added] (T5)

In some cases, an outsider who encounters prolonged social pressure and is unable to escape from such a closed environment may experience an intense personal psychological and social tension. This tension may also extend to other crew members. Ironically, it may also form cliques among the crew. An example of this was provided by T13:

"In a closed environment, people with annoying habits or personality traits quickly become a common point of discussion and mutual condemnation...In some ways it brought others in the group closer together having something in common to complain about..." (T13)

In sum, social learning is a complex, dynamic, interactive process; while an individual observes and modifies his social behaviours, so do the people around him. The following section presents a common need of the respondents to manage the border between work and non-work conditions in the polar workplace.

Space: The Border between Work and Non-Work

Most of the respondents recognised the importance of developing and maintaining group consensus and group cohesiveness within a small community. In order to 'manage' the work and non-work relationships with others cautiously, they appear to draw work, social and personal boundaries, modify own social behaviour, and choose to detach physically, socially or emotionally from a group conflict when needed. The following paragraphs and statements reported by respondents demonstrate such modification of social behaviour.

Unlike in a conventional workplace, where one can change to a different environment, a prolonged polar deployment with close proximity among 'strangers' may initiate a need to negotiate for space and to make personal adjustment. An example of this is presented in T13's statement:

"When you are away for a deployment, it's always there. You are living, sleeping, and eating, and breathing every single day. ***There is no switching off from work to...There is no differentiation between work and non-work when you are on deployment...****That's the way.*

Whereas when you are at home, the problems you are carrying in your job ***is definite*** *because there [you] could change in your environment. I suppose that separation, perhaps more easily leave work at work when you go home."* [emphasis added] (T13)

Negotiation for space may not be restricted to the physical surroundings and objects. It may extend to anything that is associated with an identity of a person in different learning contexts, for example, *work, social, self* and *polar identities*. Work and social identifies are often associated with one's role or membership in a work or social context. Self-identity refers to one's sense of own existence in the world. Polar identify refers to one's sense of association with the polar context, such as polar place, people or event. The first three forms of identities were commonly reported in this study. Examples of the identities associated with the perceptions of space, will be covered more extensively later in this section.

Three forms of space were reported by the respondents: physical, social and personal space. According to them, the perceptions and interpretations of these spaces may affect their tendency to grasp *learning cues* in a learning environment. An individual may attempt to identify and draw work and non-work boundaries in order to find his or her physical, social and personal space accordingly. For example, when explaining how ambiguity in setting these boundaries may lead to a social and a psychological tension, S7 commented on her needs for clearer boundaries in a polar workplace:

"I think it was trying to find your ***territory...*** *Like she wanted to do [a task], which I felt was my task and so I tried to make my* ***boundaries*** *and said 'OK, I see my job as this. I am happy for you to do this, and this, and this.' But I am the one responsible. So I want to make the decision about this, and this, and this.* ***So it was kind of making borders.*** *Kind of trying to establish what's yours and what's mine. Once that was done, it was really good."* [emphasis added] (S7)

The first type is physical space. Apart from natural landscape, respondents in this study divided the layout of a research station, vessel or field into non-private and private spaces. Public spaces in Scott Base may include a work station, movie, meeting, computing and dining rooms, bar, toilet and sauna, gym and library. These spaces appear to affect individuals psychologically during their deployments. Individuals may develop a sense of personal attachment to a particular space over time. For example, when describing how he became attached to his work station as it associated with an identity that he might develop during a prolonged deployment, T7 stated:

> *"...**we [winter crew] had the base exactly how we wanted it**...all our workstations were just working perfectly, how each individual like them. And then 60 people arrived [summer crew arrived]...So we are from 16 to 60 in a matter of a couple of days.*
>
> *And all of the sudden, I am basically out of the job...And they are messing up my workshop...The first couple of days I really felt really irritated...hardest part I think was definitely **going from running the place to just being feeling that you are totally unimportant.** It's a really big change. And it's quite hard to get your head around."* [emphasis added] (T7)

A shared bunk room is perceived as somewhat in between a non-private and private space. Sharing a 'personal' non-private space may indicate psychological intimacy that one might not be ready to engage. This example was evident by T12's statement:

> *"...because I was living in the same space...you do get emotionally involved as a by-product just being in the same place with someone."* (T12)

In contrast, personal or private space refers to anywhere that offers individuals a feeling of relief. These may include a psychological space or a physical private space, such as a landscape, a tent, or even a place such as McMurdo Station, where the living conditions are said to be less isolated and confined than those in Scott Base. Such example is evident in the following statement:

> *"Living in the McMurdo is entirely different than living in the Scott Base."* (T13)

A change of physical space seems to help individuals to find a balance between social space and psychological space. For example, when describing how going outdoors increased his sense of personal space in Scott Base, T11 stated:

> *"...finding ways...often **very hard to find your own space**...I called it '**secret agenda'** down there...it's important to do all those sort of things...you have to go outside every day... even if it is walking around the front door, down outside the base and down to the back door. **You have to** **get outside every day.**"* [emphasis added] (T11)

Another category is social space. According to the respondents, social space refers to a choice of social freedom, activities or social groups for them to be involved with in a polar environment. As individuals' mobility may be restricted by the natural environment, the design of a constructed environment, and safety regulations, a lack of social alternatives in terms of social circles and activities may lead to a sense of isolation and confinement. An example of such is evident in T14's statement:

> *"[I] found the living and working in the Antarctic environment a humbling and captivating experience...I closely observed the difficult adjustments some staff had to make to live in a relatively closed base environment and balancing the interactions and expectation of support staff - several female staff had a strong expectation that their social outdoor needs would take precedence over their roles and that their working day would be regulated in the same way life in New Zealand is. In fact, **weather is the controlling factor in Antarctica and that influences all movements and programmed activity**."* [emphasis added] (T14)

A lack of separation from similar social groups for a prolonged period, may cause a social and/or psychological tension. T7 reported such example in this statement below:

> *"...I get to work [in conventional environments]...and then go home, forget about it...I can talk to my partner...had somebody to bounce ideas off or just to let my frustration out...But on the base...**I didn't get the separation from the team**...I didn't have the other person to talk to...to let it all out and had a second opinion. **So it was really, really different from that aspect**."* [emphasis added] (T7)

When describing how she learned to handle a 'borderless' relationship in a polar workplace, for example, S7 reported her need to have a clear boundary in the following statement:

> *"...if you let somebody into your private [space], you are kind of committed to something. Like you are giving something away and you are vulnerable. And you are in such a situation that you can't go back. Because you always have to live like that for the 15 months with each other.*
>
> ***So once you cross the boundaries, or you let someone too close to yourself, there is no going back. So the reaction was to keep people away, keep it at the professional level, don't talk about your feelings**."* [emphasis added] (S7)

Another example is a need to broaden the social space and activities beyond Scott Base, evident in T17's statement below:

> *"...in previous years there had been an evolving dependency on the bar at Scott Base as the centre of all social activity [this led to social challenges such as drinking related problems]...Therefore, the focus needed to be changed to experiencing outdoor Antarctic life and less reliance on indoor activity. This meant running Scott Base support understaffed as people participated in outdoor experiences and having their roles covered by others."* (T17)

While the respondents who spent more time in a field with a small crew may not always have the opportunity to choose their social circles, some Scott Base personnel took a break away from the social tension with the *insiders*, if and when needed, by forming social groups with *outsiders* in McMurdo. This example is evident in T6's statement:

> *"...friendships **inside** my work group and also **outside** my work group...sometimes it's really good with your work group because you all dealing with the same work situation and they will be immediately sympathetic to whatever situation it is.*

And sometimes it is about somebody in your work group and you want to talk to somebody else. And so having friendship inside the work group and people who weren't in the work group were helpful." [emphasis added] (T6)

The last category is personal space or psychological space. In most cases, respondents go beyond the physical surroundings and objects, to include the territory that they regarded as psychologically theirs, namely, a *psychological space*. The restriction in mobility and ease of getting physical, social and emotional support in a polar environment appeared to bring about a sense of isolation and confinement among respondents. This may happen to an individual who is in a prolonged deployment, or who experiences a prolonged sense of helplessness in an undesirable condition - physically, socially, mentally or psychologically. This example is evident in S7's statement:

"During August, I was very down, but life around me was going on, everybody was so much occupied with themselves that you could go for some time before somebody clicked on that something was wrong with you. I supposed what I learned then was that the only person that is responsible for me and how I feel, is me. I think I learned to be selfish. Normally not a good look, but here it was important because nobody would give a toss and look after me, so I had to do it myself.

I had to learn to pull myself out of the mud by my own hair. I really don't know when I realised that, it seems now that this realisation just happened *[i.e., at the time when this is reported]."* [emphasis added] (S7)

In some cases, the realisation of this psychological state may reinforce an individual to move away from an existing personal space - a coping strategy to detach oneself from unbearable conditions, such as a sense of helplessness due to the loss of a family member while one is away on polar deployment. In search for novel experiences, for example, T11 went to McMurdo Station to meet more than 200 strangers who were deployed there during that season. This is evident in his statement:

"...I think in life when people are hit by tragedy or whatever, some people choose to be a victim. And cried all over and said that "life is terrible and I can't cope." I didn't take that approach. I leant to say "Well, listen. I am the kid in my pant. I still got two legs and two arms and still can walk and talk and carrying on doing my job." So rather than sitting there and said "I can't handle it", ***I just keep doing it*** *[keep looking for novel experience]...I just biked it off the hill to meet someone, or go find something else* ***to clear my head, and just get me feeling: I will be alright****."* [emphasis added] (T11)

Apart from detachment, the use of self-talk and self-distraction is commonly used as a regulation strategy to alter one's mind-set or mood. This includes seeking psychological support from an *outsider* who is neutral to the immediate work or non-work situation. An example of this is given in T7's statement below:

*"It was good because...completely fresh and we could decide where that relationship went ...****there was no history...So we can be completely open with one another****, which was really, really good.*

...you can't, often, don't feeling comfortable doing that with your workmates...or with the manager further up [the rank]...But with Z [an outsider], it didn't matter. Cause he was ***totally independent.*** *Everything I told him was confidential...so it was really, really beneficial. I could talk to him about things that I couldn't talk to anybody else about it. Um, so, there were a lot of things that I wanted to talk to P [family member] about it...if I wasn't away from the Ice, I could have talk to her about it. But because the distance between us, and she was already finding it hard to [deal with the fact that he is away from family]...I didn't want to burden her with my problems..."* [emphasis added] (T7)

This sense of psychological space may intensify when one is away from the day-to-day distractions. Some polar personnel reported that they are more likely to inwardly focus on the details in daily life during their deployments - a *mirroring effect* first proposed by Jacques Lacan in 1936 (Ragland-Sullivan, 1986). This *mirroring effect* may increase the intensity of emotions felt by individuals. Through a mirroring process, one may reframe his or her own existing world view. S1 provided such an example in this statement:

*"**Emotionally...Being able to focus on things much more clearly.** As if there's the **purity of thought**, if you like, which applies to your self-examination. You see yourself more clearly because of the starkness of what is happening around you. So you are able to focus more on you. When you are staying in the middle of the rock or the ice shelf, you really have nowhere else, as far as yourself..."* [emphasis added] (S1)

Deprival of Privacy and Resources

Depending on their experience, the polar workplace may be unusual for some respondents. First, a social community in a polar environment is normally small. The choices of social circles and activities are relatively more restricted than in conventional environments. Therefore, forming and gaining membership into a social group may be a functional motive to form 'alliances' for work, non-work and safety-related needs in this environment. Secondly, work, social and personal spaces in a polar environment are relatively more confined, borderless and less controllable by an individual. In a polar environment, due to safety and environmental concerns, individuals may experience less opportunity in mobility and fewer opportunities to alter their social circles and life styles.

These findings lead to two major learning phenomena embedded in polar environments - the deprival of privacy and resources. Sensitivity towards I.C.E. conditions, therefore, reinforces one's methods of dealing with the place, people and event in the polar workplace. This example is supported by T12's statement below:

"*When you are in an isolated environment like that, you do have to think differently. Like how you would handle something in a different manner.*" (T12)

Deprival of privacy affects individuals in a few ways. For some respondents, this may involve a desire to avoid being judged by others. Such judgement often leads to a tendency to introspection and a need to justify one's own identity and self-image. This tendency of self-evaluation indicates a need to question or to redefine one's own value system and self-worth. This may not always be a pleasant experience. For example, when describing her social learning experience in a polar winter, S7 commented:

"The relationship with my other colleagues was somehow superficial. I always had the feeling that I knew all these little details about them, what deodorant they used, what underwear they had, but I didn't know what went on in their heads.

Conversations never crossed the line of the private*...We got on OK, and worked well together professionally, but I felt very lonely... depth that I expect from relationships with people simply not there...Sometimes I felt like an alien."* [emphasis added] (S7)

Similarly, S11 reported an examination of self as a result of an unpleasant social learning experience in his statement:

"From the negative feeling, I think I learnt quite a lot about my character...about others' characters...For example... I think people are...accusing me which I think it's completely incorrect." (S11)

In order to function within a small community such as a polar workplace, one may experience a need to isolate oneself from a social conflict. Unlike in a conventional environment, where an individual may have the liberty to disengage from an undesirable environment at the end of a day, these forms of 'escape' or search for 'comfortable' space appear to be limited in polar environments. At times, respondents deprived of this free will appear to sense a need to 'plan' for an 'escape'. These respondents reported a sense of context intensity or 'social pressure' to behave socially different in I.C.E. conditions. T8 provided an example of this in his statement below:

"...you got ***such a pressure-cooked environment which you learned about people a lot quicker****...while I was enjoyed social interaction...****huge learning curve from dealing with people*** *for a long time and actually learning about myself on how often I would retrieve away and do something by myself...It's pretty much* ***a self learning curve,*** *learning a little bit about how I conducted myself."* [emphasis added] (T8)

As a result of these pull and push factors, respondents reported a wide range of social and emotional learning experiences related to I.C.E. conditions.

The deprival of privacy leads to a need for polar personnel to find a balance between privacy and functionality within a polar community. In order to find a balance between what was desired and what was available in an I.C.E. environment, respondents learnt to categorise, set, regulate and modify social relationships and boundaries, tailor their communication such as topics, methods and interactions with others, participate in selected social activities, space and informal groups, as well as modify their work or social roles, behaviour and perceptions. The urge to learn and to modify one's own perceptions and social behaviour, therefore, increased one's intensity to learn.

Scarce learning resources may also reinforce implicit learning. Generally, these resources have three main characteristics: utility, quantity or availability and usage in producing other resources. These include human and physical support for task, social and psychological needs, such as facilities, equipment, materials, as well as information and communication technology. Depending on an individual's needs and the availability of resources, polar personnel may seek these resources within or outside a polar environment. As shown in the following sections, work and non-work-related support for task, emotional and social learning may vary in term of the forms and degree of need.

Work Related Support

In some cases, a lack of facilities, equipment and materials may initiate implicit learning of task and emotion-related knowledge. This example is evident in T17's testimony:

> *"Typically in the telecommunications world, it is critical to restore equipment as soon as possible to maintain emergency services. In Antarctica, it is simply not always physically possible to do everything you would like to when you would like to. I have learned it is OK to step back, relax, and say to myself "I have done all I can for now, there is nothing else I can do until...." and not fret about it."* (T17)

In other cases, a lack of information and human support may stimulate task, emotional and social learning. As mentioned earlier in this chapter, only one or a handful of personnel are deployed in each occupation per season. Some novices in Scott Base may learn about their tasks explicitly from old hands during the period of a handover, usually between one to four weeks. After that, the individual is left to work and learn independently. In some cases, the lack of support

during or after handover may lead to the use of different coping mechanisms, for example, self-reliant, learning-as-it-goes. An example of this is given by T11's testimony below:

> *"It was very difficult to start...we were trying to figure out as we went...Reinvent the wheel if you like...the information [was] there, but we just did not have access to that until it gets shown [by chance]. And* ***we won't be able to get to show for some time because there were so much else that was going on****...****the knowledge that people had in their own head*** *that they might not have the time to explain...there was nobody handing over to me. It's the first position...My supervisor had worked in this job previously. He gave me as much information he was able... But he was also handing over to four other girls and he was the only source of information for all of them... but a* ***lot of other things I sort of figured out along the way****."* [emphasis added] (T11)

When it does not involve life-and-death consequences, the most common methods reported were observation and trial-and-error. An example is given by S7's statement:

> *"...learning by watching an experienced person and learning by trial-and-error. I still think this is the best way in Antarctica. Theory doesn't get you anywhere,* ***because conditions are so different from anywhere else so that rules and techniques always have to be adapted to Antarctic conditions.*** *Learning by trial-and-error will take much longer and can be sometimes quite frustrating, but it means you can find better ways of doing something and exceed previous standards."* [emphasis added] (S7)

Non-Work Related Support: Social and Psychological Support

Choices of social and psychological support appear to be a tricky and challenging issue. Too much or too little support, to whom and to where to look for support may conflict with the individual's need for privacy. This is evident in T13's statement:

> *"...I observed on a number of occasions that people suffered from loneliness, sometimes to a great degree. This effect started by some random events, such as news of some sort from home. The person concerned then chose to isolate themselves somewhat from the rest of the team and dwelled on their problem alone. A lot of these problems would have not*

amounted too much if people affected had sought company. There is something uplifting about being in the company of others when you are isolated in places like Antarctica.

During my second winter at Scott Base, I had occasion to walk the whole length of the base and go into every work area and not find another person around. It took three-quarters of an hour to find someone else. While this did not affect me much, ***it serves to show that isolation can become real to anybody in a vulnerable state."*** [emphasis added] (T13)

Under such circumstance, an individual may rely on himself or herself instead of others for learning. According to the respondents, observation, trial-and-error, and self-reflection are the common implicit learning methods. An example of this is provided by T8's statement:

"I have given myself a good mental kick on the backside...giving myself a little pep talk in my head and saying hey T8 you know, you are going down the wrong track here. Get it together. Think about the happy thing you know or whatever. Generally, my down moments might only last an hour...if I managed to pick myself up again." (T8)

Failure to self-heal or obtain social or psychological support for a prolonged period may result in psychological distress at an individual level and for the crew. An example of this is given by S3 in her statement that:

"I found the second deployment the most challenging emotionally of my three trips. ***I had to draw on a lot of inner strength to cope with some of the interactions with other group members and I found that this affected my ability to deal with the practical challenges as my focus was being diverted by these challenging interpersonal relationships****.*

I had to really try and control these negative emotions so I could function effectively by analysing the situation and getting ***a sense of detachment and to realise that the situation and the group dynamics were strong contributing factors rather than personal inadequacies****."* [emphasis added] (S3)

Choices of learning methods appear to depend on an individual's perceived ability to identify and retrieve learning cues and stimuli between an original context and a transfer context. These cues may involve a learning environment, activities, content, needs, resources and individual factors such as their experiences, personalities and identities. In other words, the degree of differences or similarities between an original context and a transfer context is based on an individual's perceptions and interpretation of the learning cues in these contexts. An individual tends to be more aware of his or her own learning process when the gap between the two contexts is either very different or very similar. When comparing his learning methods in a conventional and polar environment, for example, S1 stated that the learning principles used are similar, but they were varied by the degree of learning intensity in a polar workplace:

> *"I think it's kind of similar [learning methods used] because...I am the sort of person who learns by experience and things. That's the way I learned best. By experiencing things. So experiential learning is very similar here as it is on the Ice, except that on the Ice...is more strange."* (S1)

Most respondents reported the use of their own learning habits for polar learning. These learning habits resumed until such a time when there is a need for a shift of learning paradigm. Two conditions may trigger such an evolution. The first condition, for example, is evident by S7 who commented on the need to be creative when a learning demand was too different from her prior experiences:

> *"Just utilise what is there and* ***think outside of the square****...Learning by trial and error will take much longer and* ***can be sometimes quite frustrating,*** *but it means you* ***can find better ways of doing something and exceed previous standards."*** [emphasis added] (S7)

Alternatively, a lack of resources to support the present learning needs may also bring about a shift in the learning paradigm. Because of the extreme natural environment, constructed environments, such as research stations, field sites and vessels, are therefore designed to accommodate human needs in polar regions. The physical layout, ease of obtaining resources, degree of freedom and choices of physical, social and personal space in a constructed environment may affect an individual's perceptions of isolation and confinement. These perceptions resulted in a

wide range of adaptation behaviour being reported. This includes a need to be self-reliant and to modify one's own work methods and techniques in the field, for example, as evident by S7 in her statement:

> *"Because you have **limited supplies.** You have limited ways of **information,** you have **limited logistics...**there is no customer service there [polar environment]...**So there is simply not [having] that surrounding, that networks, the support like normal places...**"* [emphasis added] (S7)

Changing Organisational Factors and Needs for Learning

Changing organisational system, structure, process and people within a workplace such as division of work, work autonomy and control, may affect the acquisition and utilisation of tacit knowledge in a polar environment. This section explains why a returnee may need to reinvent a *learning cycle* from season to season.

First, the ways to carry out one's work appears to be a *dynamic social process* rather than just a written statement of a job description; most jobs require a certain degree of interaction with others. Therefore, as workmates change from season to season, so do the expectations or the ways to carry out the same task. Individuals may need to learn new unwritten rules and norms related to work and non-work. When comparing how to perform the same work role in two polar deployments, for example, T10 commented:

> *"...[the tasks were] Very, very similar. What changed is the people [who you are] interacting with...The staff...changed and so you have to be more involved or less involved and support [others] in different ways...**The tasks that you need to complete don't change, but the way that you want to go about doing that, interacting with people changed...knowing a lot of other things that are unspoken**."* [emphasis added] (T10)

Although it seems to make sense to deploy old hands, some respondents criticised the lack of openness to alternative work practices and new crew members. Because some codified knowledge, such as organisational records and on-the-job training, may not catch up with the changes at work, the cycle of implicit learning continues among some respondents. An example of this was given by T10 and T11 in their statements below:

"Previously the people who have the job had worked in Antarctica New Zealand before and had worked out how it used to work...So there is a constant cycle of the people who already have the previous Antarctic experience in the field...At the end of the season, by looking back at my experience at the start of the season, if I know X [information], it would be really useful." (T10)

"It's not documented. It's not shared in liked an open sense...So that's a lot of that sort of stuff ...I just did the best I could to document the various things that I found, and waiting for my, er, the next person to take over from. But ***there are just lots of things that just keep finding out and just being able to think on the spot."*** [emphasis added] (T11)

A lack of physical, social and psychological space seems to be more intensively felt by individuals within a small group. In other words, deprivation of space causes one's need for privacy. Although the physical proximity between people may be close, the psychological distance may be carefully guarded and regulated accordingly. When describing about his social learning experience in I.C.E. conditions, for example, T14 stated:

"Interactions in a closed environment...Working and living at Scott Base is rather like living on a ship. You interact daily with the same faces through living, sleeping, eating and working and socialising. Strong relationships, empathy, good leadership and a sense of humour are absolute essentials. It was my first big immersion in ***'emotional intelligence'. Self awareness, social skills and motivation*** *came to the fore. You have to be* ***prepared to confront*** *where necessary,* ***deal with the hard stuff, make sound judgements around behaviours and then gently move on****."* [emphasis added] (T14)

Although briefings on such issues of polar adaptation are often provided to Scott Base personnel before their deployment, this is not necessarily a common practice amongst Antarctic programmes. An example was evident in S11's statement:

"When I went to the Ice [for] the first time...I was completely unprepared to go to the Ice. Packed the bag and go. I was asked if I would like to go to Antarctica. I said yes...I have no discussion about this before I go...to really expecting that..." (S11)

Most respondents suggested that implicit learning of work and non-work related knowledge is essential in I.C.E conditions.

3.4.3 Disparities of a Learner

Although a learning environment provides a framework for the learning of tacit knowledge, what makes a significant difference in a learning process is the learner. One may or may not pick up a particular learning resource and learning cues, based on his or her perception and interpretation of the pull or push factors in a learning environment. This section reviews the perceived unusualness, time, learning cues and intensity associated with implicit learning.

Perceptions and Cues for Learning

Mostly, task, emotional and social knowledge and the learning methods used, may be affected by the degree of unusualness, learning cues and intensity perceived by a learner at a given time. These perceptions may depend on an individual's experiences in a conventional or an I.C.E. environment. These experiences may, or may not, be directly related to polar work. They can be classified into three categories. The first type deals with outdoor activities such as camping, tramping, skiing, and other field experiences associated with alpine, snow or bush. The second type concerns their professional background, such as their technical knowledge, working conditions and stress level in previous job(s). The last category relates to the emotional and social skills associated with the close proximity with people.

Respondents with a military background or high autonomy work reported a sense of familiarity with I.C.E. work conditions during their polar deployment. However, both the civilian and military personnel seemed to feel unusual when it came to interacting socially with one another.

Most respondents who reported this sense of unusualness towards a learning environment, content, process or people believed that this phenomenon may be caused by being the minority in a small community. A 'minority' may be defined by sex, polar experience, occupation, social behaviour or personality. These include being the only female in a male dominant group or a novice among the old hands. An individual often used what he or she is already familiar with as a base to

measure and to decide what is considered as unusual for himself or herself. Subsequently, this worldview may be broadened when he or she is exposed to different learning environments, content, processes or people.

However, when the degree of unusualness exceeds an individual's tolerance level at a given time, he or she may feel an intense need to change the condition. The term 'intensity' is defined here as the strength, amplitude or level of feelings toward either a learning environment or a learning process.

Context intensity appears to take place when one is exposed to unfamiliar circumstances, such as competing priorities, scarce support or resources, and prolonged exposure to a lack of privacy during a polar deployment. This form of intensity gives rise to learning demands. When describing how polar workplace conditions motivated him to learn, T17 stated:

> *"There are probably more external social influences back in New Zealand which contribute to how people interact and behave.* ***Antarctica tends to have intensity*** *– I suspect that (albeit unknowingly) people try to achieve as much as they can into their time there...Observation of others' reactions and body language toward own work performance and effort."* [emphasis added] (T17)

In order to cope with learning demands, an individual may report an urgency to learn in order to adjust physically and psychologically, namely, *learning intensity*. T13 supplied an example of this in this statement:

> *"**The whole process of being down here is that you learnt fairly quickly. Otherwise you won't be able to handle all.**..You will be sort of concentrating on a certain field back home...Down here, you sort of concentrate on every field...for example, the engineers not only look after the power generation and the plumbing of the place...a whole lot of things that they have to pick up and learn and become familiar with. Familiar enough to make sure that they...have the place to run ...next year and also to hand over to the next person who comes in...who is going to be in the same situation as they were the year previously."* [emphasis added] (T13)

The pressure to cope might be caused by a need to deal with multiple variables within a short time interval, for example, the amount of information and people to work with, the pace of learning, as well as the amplified emotions related to learning when one senses an urgency to close a learning gap. This example is apparent in T1's statement below:

> *"It probably wouldn't be much different learning this back home; however* ***the pressure to do so much in such a short time probably wouldn't occur to the same extent****."* [emphasis added] (T1)

These emotions appear to be more intense when individuals focus inwardly. T6 gave an example of this in the following statement:

> *"I think it's something about in the extraordinary environment that you feel everything more* ***intensely and it makes you reflect on things****..."* [emphasis added] (T6)

The following section presents the findings of the phenomenological perspective of *self* and how this perspective may subliminally affect one's identification and utilisation of learning cues in different learning environments. In particular, the concepts of awareness, personal continuity, identity, and emotion associated with implicit learning, will be discussed.

Self-Awareness and Recall of Learning

As shown in the Revised Adaptive Implicit Learning Model for Polar Deployment (see Figure 13, p. 80), respondents appeared to recall their learning experiences based on two time-frames. Most learning phenomena reported seem to surround the interplay between a sense of *self* and its association with the internal and external world at a particular time. That is, self, context, time and consciousness, are interrelated. These variations explain why the frequency, abstractness and confidence level, as well as the ease of reportability of a task, emotional and social learning content and process vary across time. The first part of this section presents the findings about consciousness based on Block's model, such as phenomenal, self, access and monitoring consciousness, as suggested in Chapter 1 (Block, 1995, 1999, 2005; Cleeremans & Jiménez, 2001; Rosenthal, 2002). The second part of this section deals with the phenomenological perspectives of possible selves (e.g., Brown, 1998; L. L. Schmidt et al., 2005).

Instead of a "unitary phenomenon" or an all-or-none process or property (Cleeremans & Jiménez, 2001, p. 12), consciousness may be divided into components and degrees. These include phenomenal, self, access and monitoring consciousness, as well as thick and thin phenomenological perspectives of a learning event, as suggested in Chapter 1 (Block, 1995, 1999, 2005; Hogg et al., 1995; Brown, 1998; Loizou, 2000; Cleeremans & Jimenez, 2001; Rosenthal, 2002; Fitness & Curtis, 2005; L. L. Schmidt et al., 2005).

As a learning process may continue after an initial learning event, an individual may pick up a learning cue in a *similar but not necessarily identical 'transfer context'* after an initial learning event. This process can occur either intentionally or unintentionally. In other words, on-going learning demands and a sense of perceived identity at different times, may contribute to the phenomenological perspectives of a learning experience. Compared with other respondents, some respondents appeared to engage in introspection of their own mental states more easily. The notion of one's self and identity may be portrayed in one's justification of self-image, either intentionally or unintentionally. As it interacts with internal and external world, self is complex and dynamic. The following paragraphs present the forms and levels of self; each type is supported by illustration from the respondents.

When recalling a social learning experience, for example, T6 became aware of her *past, present* and *future self* within a context, at a slight different degree of awareness and perspective. This continuity of self is evident in her statement below:

> *"But being the only woman in the group, there is a little bit different again. And I think...on reflection, I mean this is something like thinking it through later, I think I ended up making sort of strong alliance with one, or often one or two people and sense of like having a boyfriend sort of things to make my position really clear, so that I wasn't sort of being available to the whole group...I don't, nobody made me feel vulnerable like that. There wasn't a sense of "I need protection" from these terrible men. Not at all.* ***But I guess, it was subconsciously, something like that...I don't know****...it's a little funny.* ***When I looked back, I think "Really? Did I really think like that?" It happened like more than once... the next time I went down, something similar****."* [emphasis added] (T6)

Similarly, when illustrating a social-related learning experience, T11's awareness of self-continuity increased:

> *"But now I would be more relaxed...Because I am older...Perhaps not older, but more experienced. But I am not completely sure about that. Perhaps it's just going to be just the same. I never talked to specialists, perhaps psychologist about that. I don't know. Perhaps it will be just the same. I will just flee out again...just by getting older...not older people are just necessarily better...but I think my personal view, now that I have of a lot of other people in other situation, I will just see it in a different view. I think I could...I can do better. But it doesn't really help...I am not in the situation anymore and at that time I haven't have the knowledge. What is important, what is important measurement? So it's hard to say."* (T11)

This capability to introspect *self* indicates the presence of *access-consciousness* (Block, 1995, 1999, 2005). Usually, respondents appeared to recall the interplay between *self* and learning environment more easily when describing a learning process compared with a learning content. Although implicit learning process may be the means that leads to a learning outcome, it is often embedded in the conscious mind of an individual. This may be caused by one's accessibility to own consciousness at different stages of learning through simple or complex reflection.

When describing an emotion-related learning, a delayed awareness of an implicit learning behaviour appeared to take place years after the incident, as evident in S7's statement:

> *"I had to learn to pull myself out of the mud by my own hair.* ***I really don't know how and when I realised that, it seems now that this realisation just happened****...I had to think hard about these 'emotional lessons' because I think this probably happens, more than all the previous examples, in the subconscious"* [emphasis added] (S7)

Similarly, T1 experienced a delayed awareness of a task-related learning, as illustrated in her statement below:

> *"I learnt how to work by myself doing a boring [task] for extended lengths of time with little to no social interactions during that time...****I wasn't aware I learnt anything new at the time, although I did notice*** *I started working at night and weekends in the lab at university*

after that so I wouldn't be disturbed because I realised it's easier to focus." [emphasis added] (T1)

This capability to introspect and monitor one's own *self* indicates the presence of *monitoring consciousness* (Block, 1995, 1999, 2005). Not all the four types of consciousness (phenomenal, self, assess and monitoring consciousness) and continuity of self mentioned above, are noticeable by an individual at all times. Illustrated in T11's statement, below, this internal monitoring process of one's state of the self (Block, 1995, 1999, 2005) may be found in three possible forms: 1) the inner perception in a form of phenomenon consciousness, 2) the internal scanning in the form of information-processing, and 3) the metacognitive notion in the form of higher-order-thought.

"*Mostly **thinking about things that affect me and trying to identify** what I am stressed out...talking yourself out of it. **Trying to catch myself** from negative self-talk... Just **changing** my thought patterns, just sort of **noticing** that I was **thinking** negatively about a situation, **trying to think** about the positive. Again all these things were things that I knew about previously. I sort of called them into play if you like. Use my resources down there which I had done in the past, but it's just another time that I knew I have to do it.*" [emphasis added] (T11)

In other words, *learning environment* is no longer referring to just a physical learning condition. Rather, it takes effect if, and when, one becomes conscious about a learning cue or stimulus. Time is, therefore, defined as a measuring system used to quantify *access conscious of self* in association with a learning event. Reporting of a learning content or a process may be qualitatively varied at each point on a continuum. This phenomenon may more easily be detected through *double loop learning* compared with *single loop learning*. The following section reports how emotions may transform together with the learning processes.

Learning-related Effect: Intensity and Anxiety-Neutral Condition

Respondents in this study appeared to report a wide range of emotions associated with different stages of their learning, from "novices" to "old hands". This finding supports the Learning related Emotional Effects from 'Novice' to 'Expert' Model (Figure 7) discussed in Chapter 1. Note that the term "novices" here, may mean having less experience in a polar environment but they may not necessarily be new to specific learning content. This applies to individuals who have prior experience in other I.C.E. environments or similar learning contexts. One may experience a wide range of emotions throughout a learning process across time. These involve the frequency and the depth of changes, the tone of an emotion such as pleasantness or unpleasantness, and how lightly or strongly one felt emotions before, during and after a learning event. These emotions are directly affected by, and impact on, a learning process.

During the initial stage of learning, a novice who was mentally, physically or psychologically unfamiliar with a learning situation may be affected by a sense of anxiety or a lack of security. T6 provided an example about the fear of embarrassment, as a novice, in her statement:

> *"The acute feeling of embarrassment is just the lesson at the time. And think that OK I will try to be more careful. Trying to learn something out of the experience."* (T6)

This may lead to a sense of uncertainty and uselessness. The intensity and urgency of a learning need may trigger an individual to move away from his or her usual anxiety-neutral condition (or 'comfort zone' in layman's terms). These emotions may elicit a need to close a learning gap, as illustrated in T5's statement below:

> *"...during my first season I often felt completely useless. Inexperienced and this would cause me to hesitate to do a lot of things. As time progressed - helped probably by learning a lot and the need to be a part of a team and just do the work, I managed to usually take the 'useless' feeling and put it more constructively into learning how to do a new task."* (T5)

This may be followed by a sense of curiosity, interest or urgency to solve immediate problems, as evident in S7's statement below:

"Just utilise what is there and think outside of the square. And trying to fix things. That's the main priority to get it running. Gets it running fast...It's mainly trial and error. When you use the instrument, you hope nothing goes wrong. But pretty much...everything...something goes wrong..." (S7)

Positive or negative emotion may reinforce subsequent learning. If positive outcomes result from an attempt, this may lead to a sense of pride, excitement or confidence. For example, the respondent who gave the quote immediately above reported a positive emotion from conducting a science experiment through trial-and-error:

"*Because you figure it out by yourself and you get satisfaction out of it. Now it's finally working because of your doing."* (S7)

In contrast, one may experience negative feelings, such as frustration and helplessness, when he or she is unable to close a learning gap. These emotions may continue after the initial event or years after an unpleasant deployment. Two respondents gave such examples in their statements:

*"...**unpleasant emotions**. **I am not very strong, and felt frustrated that I struggled to work with equipment.** This left me feeling a bit **helpless.** I felt this **reasonably often**, every couple of days for a short period. Also, once I lost equipment that wasn't mine down a hole and was very upset about this for a few hours and cried..."* [emphasis added] (T1)

*"I am **a bit more wary now**...I try to go with the **"less-talk more joking around" approach**, but I find it hard, because it **feels superficial to me** and the **depth that I expect from relationships with people [is] simply not there.***

*I faced a similar problem trying to get on with people while ice drilling...**I ran into the same problem again;** I simply **couldn't find a common denominator. They mainly joked around...I felt like an alien.** I suppose the summary of this is that I **still haven't learned how to connect with people that are so very different from me.** We got on OK, and worked well together professionally, but I **felt very lonely."*** [emphasis added] (S7)

At a glance, these examples may not be too different from the learning phenomena in a conventional environment. However, most respondents reported a higher sense of learning intensity during their polar deployment compared with in a conventional environment. For example, the pace of learning is perceived as faster and more intensely felt in a polar environment. Three respondents illustrated this phenomenon in their statements:

> ***"More intense and focussed learning experience..."*** *As already stated similar skills needed to successfully cope in the environment I work in as* ***teamwork*** *is required there to be effective.* ***The need to learn and get it right is more important on the Ice because of the nature of the environment...***
>
> ***Off the Ice the situation is not as intense so learning needs not be so focussed.*** *The* ***constant tension*** *between focussing upon* ***practical everyday stuff*** *necessary for survival and thinking about...related to my... practice is* ***much more apparent in the Antarctic where it's less forgiving if you are not on to it.*** *This is a* ***juggling act I have learnt to live with."*** [emphasis added] (S3)
>
> *"[learning process is] More intensive situation on the ship with greater time pressure and responsibility. [Learning] Process is slower at home."* (S13)
>
> *"It's intense and it's short. It's all new."* (T6)

The perception of intensity may change when a novice transforms into an old hand. An example of this was given by T12 in the statement:

> *"...because that environment you are working in, I suppose it's so intense and so isolated and so different that all of the sudden, what happened back in the Christchurch was irrelevant and you felt you're embedded in the place and you had that sense of ownership and all of the sudden the new ones (novices) have come along...You are looking at them in a different way. You are like almost looking at them in a way that people would look at you if they have been there before and they are working with you the newbie. Quite different..."* (T12)

The frequency and depth of changes, as well as how lightly or strongly one felt emotionally seem to depend on how big the learning gap is between an original context and a transfer context, as perceived by an individual. One of the respondents provided an example of this in her statement:

> *"...growing up in an outdoors of family with brothers. I think this truly helped as I had no misconception about how uncomfortable I would be at times. And [I] probably had a better, more effective time because of it."* (T5)

The degree of intensity perceived by an individual and the 'choices' of his or her learning approaches may be influenced by temporal factors. When an individual is exposed to a prolonged duration, short interval, and high frequency of learning events, he or she is more likely to report a high degree of learning intensity. This was evident in S3's statement:

> *"Off the Ice the situation is not as intense as learning needs not be so focussed. The constant tension between focussing upon practical everyday stuff necessary for survival and thinking about [my work] is much more apparent in the Antarctic where it's less forgiving if you are not on to it. This is a juggling act I have learnt to live with."* (S3)

Temporal Factors and Learning Intensity as the Drivers of Learning

Temporal factors, such as the duration, interval and frequency of learning event(s), may contribute to implicit learning. In a controlled environment, such as a laboratory, these variables can be manipulated by a researcher. However, in natural settings, such as a polar workplace, these variables are affected by the dynamic changes of contextual cues or stimuli within a learning environment as perceived by an individual.

Duration of the learning process is defined here as the amount of time that an individual may take to learn the necessary knowledge. Some respondents reported the learning of a particular piece of knowledge during their first deployment, others commented that learning continued years after the deployment, even though he or she may not be aware of it.

Time interval refers to the time gap between the occurrence of two learning events. This factor may involve a consolidation of memories and learning experiences in the 'real world'. In other words, the time gap between two learning events perceived by an individual may be as short

as milliseconds at a small-scale, or as long as years at a large-scale. These two time-frames are evident in the discussion in Section 3.2.

The third variable, *frequency* of a learning event, is defined here as the number of occurrences of a similar learning event per unit time. As with the previous factor, not all learning events are repeated during a polar deployment, especially during a short deployment. Some learning instances may occur more frequently within an extended polar deployment, others may happen just once. In most reported cases, learning incidents seemed to take place before, during and after a polar deployment.

Respondents did not seem to be consciously alert to these temporal factors in daily life, unless the learning content appears to be 'unusual' or 'meaningful' to the learner. An individual may react automatically at the time when he or she is adapting to a social condition situation. The creation of meaning appears to be a by-product of after-event learning. When describing how she learnt to modify her social behaviours, being the minority in a male-dominated crew, T6 commented on a delayed awareness of the temporal factors associated with her learning:

> *"...but it wasn't consciously me thinking "OK, I need to work it out". Not at all, it's just one of those things that happened. And the reasons why I think...in some ways a sort of protection mechanism because it happened again the next time."* (T6)

Context Intensity and Learning Intensity

Two forms of intensity appeared to be associated with implicit learning in a polar environment: context intensity and learning intensity.

Context intensity refers to the perceptions about a learning environment. This form of intensity may associate with a social or non-social context. For example, social context intensity may arise from day-to-day social interactions, as evidenced by two respondents in their statements:

> "*Social interactions are required in all walks of life. However, in a field camp the smallest silliest things others do can be a major source of irritation...the way someone brushes their hair, or where they always sit, or the way they ALWAYS say "howdy" after 4 weeks of living with them can be so annoying. I tell [novices]...but they often don't really realise this until*

they get there. Off the Ice you can always get away from people, in a field camp this is not so easy. Dealing with this is a problem. Some people can't do it very well." (S4)

"I think the friendships are developed ***more quickly and more intense*** *on the Ice because you are* ***sharing a much more extreme environment and you have no escape...****you are thrown together and you got to make the most of that."* [emphasis added] (S1)

Non-social context intensity may link to a tension to resolve immediately problems at work. According to the personnel who experienced different physical environments, such as a sea vessel, research station and a normal field camp, context intensity is determined by the degree of remoteness and ease of getting support from the 'outside' world.

In some cases, non-social context may associate with work pressure. For example, in the case of T11, working in Scott Base was perceived as relatively less stressful compared with working on a vessel for a similar job, even though his deployment to Scott Base was longer (12 months) than on the vessel (5 months). In other words, work pressures, such as the urge to maximize the deployment outcomes, are perceived as relatively higher on a vessel by some respondents.

Another example of this is evident in T12's statement:

"...[Scott Base] is isolated, but not nearly as much...got the weather stations just up over the hills...you can get out and do things. ***You can get off the base.***

Working on the ship...you are very isolated and also you are working on shifts...So 12 hours on and 12 hours off...my other shipmate he comes in from midnight to midday... I am the IT person on board. People always have issues with the computers every day. I never get a [day off] and that's just the reality...particularly like at sea, communication back home is very important to people and the only communication is email and satellite phone...Cause the areas we take the ship, often has no cell phone coverage in New Zealand. So email is relied on heavily, so if people aren't getting emails or they think there is a problem there, they will come knock, knock on your door. So...It's the deal there.

*And then all the instruments on board. Because I supplied all the electronic support****...It's a lot more pressure than working on the Ice, at the sea****...We only got the vessel for 35 days,*

*so if **anything goes wrong, I pretty much have to fix it on the spot, and that can be day or night.** So I can get up 3am in the morning if someone said that 'Oh, this is not working and we are about to deploy. Could you come to fix it?'...**So you are under a quite a bit of pressure."*** [emphasis added] (T12)

In other cases, non-social context intensity may relate to a sense of familiarity with a learning environment and a positive feeling about a new learning situation. An example of this was given by T6 in her statement:

*"The first week there [polar environment] the people there are sort of useless, because it's such a big buzz. It's exciting, it's all new, there are so many rules, there are all the clothes and all sorts of things...they are all new for people to deal with and it's just quite a lot to take in...It's very **intensive, it's very exciting**. But you are not really [in] the space in order to step back. 'Now, what do I wanted to do?...What's my job?' All those sorts of things.*

*Whereas when you go back [subsequent polar deployments], you still have the buzz but not that **extreme...**I sort of felt like home there quite quickly. That was really interesting to me that I **felt the confidence quite quickly**. Just about how things work there."* [emphasis added] (T6)

Individuals' sense of contextual intensity can lead to their focus on a learning condition. This may result in a sense of learning intensity. When an individual becomes more aware of a need to close a learning gap, he or she may experience a sense of learning intensity. One of the respondents gave this example in his statement:

"Because you reflect about it. You think about it. You also spend more time with the person. You have more time to think about this...

In our busy life [conventional environments], you probably don't spend so much time think about this, their characters. So it's getting much more personal." (S11)

If the learning experiences between a conventional and a polar environment are very different or very unpleasant for an individual, physiological and psychological tensions, as a result of the above intensity, may continue years after a deployment. One of the respondents gave an example of this in his statement:

> ***"The intensity and expectation would almost certain be less*** *[in conventional environments]. Other diversions would exist and coping mechanisms would be better. At home you can conjure an excuse not to be present [or move away from an undesirable situation] owing to competing priorities...**On the Ice, it's somewhat more difficult in that close and small environment."*** [emphasis added] (T14)

Given limited time to accomplish polar missions, a large amount of task, emotional and social-related information to deal with at one time, and a high need for fast paced, self-directed and self-supported learning, individuals may find the situation to be one of high intensity. When the degree of learning intensity is larger than individual's 'comfort zone' or anxiety neutral condition, he or she may experience a steeper "learning curve". Note the "learning curve" presented in Figure 13, above, is, therefore, varied at an individual level.

3.5 Summary

This chapter began by presenting the method of analysis used in this study. The earlier part of this chapter introduces the patterns of implicit learning. In light of the data collected, a new learning model was proposed for a polar workplace. In this revised model (Figure 13), time is defined as the interval between two similar learning incidents. The respondents perceived these intervals differently. Learning in the first duration takes place during the first polar deployment. In the second time-frame, learning transfers across contexts, before and after the first deployment. These include similar, but not necessarily identical, prior learning context(s) or subsequent deployment(s). Conscious awareness of learning takes effect if, and when, one is aware of a learning cue or stimulus.

In light of the data collected, task, emotional and social-related learning content and processes reported appear to differ in terms of their range, frequency, ease and descriptiveness. Usually, repondents were more descriptive and ready to report a task or social learning content and

process than emotional. Although an implicit learning process may be the means to a learning outcome, it appears to take a 'backseat' role in the conscious mind of an individual.

Further analysis suggested that the concept of disparities may serve as the drivers of learning. Transfer of learning takes place when an individual closes the learning gap(s) between an 'original context' and a 'transfer context'. The term 'original context' refers to the initial occurrence of a learning incident as perceived by a learner, rather than an initial learning incident that can be objectively observed or verified by a third party.

Two aspects of disparities serve as drivers of learning. The first aspect concerns a learning environment. Common themes, such as the perceptions of I.C.E. conditions, small group attributes, as well as the border between work and non-work, were presented. Lack of privacy and scarce resources in a polar workplace seem to offer the opportunities for implicit learning in I.C.E. conditions.

Although a learning environment provides a platform for the learning of tacit knowledge, what makes a significant difference in a learning process is the learner. That is, a learner may or may not pick up a particular learning resource and learning cue, based on his or her perception and interpretation of the pull or push factors (i.e., learning cues) in a learning environment. These disparities influence individuals' perceptions and sense of unusualness, time, learning intensity, as well as the emotion associated with implicit learning. Two forms of intensity, namely context intensity and learning intensity, were reported. The degree to which an individual adjusts his or her perceptions may be influenced by a similar, but not necessarily identical, prior experience. This may explain what is perceived as unusual by a respondent may change with the exposure to such a context. Likewise, what is perceived as 'unusual' by one respondent may not be the same for another.

Chapter 4
General Discussion, Conclusions and Recommendations

4.1 Overview

The previous chapter highlighted three major findings of task, emotional and social learning. The first finding is that implicit learning of tacit knowledge takes place in a learning environment that is composed of physical-technical-organisational (P-T-O) and social-cultural (S-C) learning surroundings, context or conditions. The second finding is that the polar workplace is perceived as isolated, confined and extreme, and this has a bearing on learning. Finally, a wide range of learning content that consists of three themes was reported: privacy issues, small group attributes and scarce resources. The disparities between learning environmental factors and learner factors may affect how an individual perceived these phenomena.

In light of the above findings, this chapter divides the discussion into three sections. The first part reviews the challenges of conducting this research and introduces the revised learning models. It explains how these new models integrate into a general model of informal workplace learning for a polar workplace. These models will be discussed in light of their theoretical contributions to implicit learning.

The second part of this chapter examines the findings of task, emotional and social learning content compared with previous findings in polar psychology. Particularly, it analyses the new findings about learning content, processes and their theoretical implications for I.C.E. environments.

The last part of this chapter will provide recommendations to Antarctic sojourners and their managers, from the aspect of self-management and organisational management. It explains the ways to apply these learning models and findings in other I.C.E. workplaces or deployments. In view of the challenges in conducting implicit learning research in a polar workplace, this study offers suggestions for future research.

4.2 Revised Models and Their Implications for the Gaps in the Literature

Before we begin to discuss the results, it is necessary to highlight some of the constraints unavoidably introduced by the research design. First, the scope of this study is limited to the recollection of polar experiences; the data may be subject to biases normally associated with memory. Although self-reported methods, such as interviews and questionnaires, help to retrieve implicit learning data, they may present an opportunity for the respondents to control information sharing. According to some respondents, learning issues and tacit knowledge can be sensitive information to share due to "the smallness of the Antarctic community..." (T5). Thus, care must be taken in the interpretation of the data. The triangulation method (Chapter 2) employed in this study aimed to reduce the possible effects of these biases.

From the point of view of the circular approach to learning theories (see Figure 2, Chapter 1), self-reported learning experiences depict the behaviours and cognitive processes that may take place during implicit learning of task, emotional and social knowledge. According to the findings in Chapter 3, the manner in which a gap in learning is closed depends on the learning environment and temporal factors, as well as a learner's perceptions of these factors. It should be noted, however, that the current study did not measure 'learning behaviours' that take place before the reporting of a learning content and process. This remains an area for future research.

Revised Models and Their Implications for the Gaps in the Literature

While physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments frame I.C.E. conditions in a polar workplace, an individual's perception and interpretation of these conditions may affect how he or she becomes aware of a gap in learning, a learning need and a learning cue in a learning environment. Instead of a static property, phenomenological perspectives of implicit learning and locus of identities across contexts further suggest that these learning experiences are contextualised, multifaceted and evolving processes.

The respondents in the current study viewed implicit learning processes from two time-frames in a *non*-linear way (see Figure 13, Chapter 3). Though learning events in the first time-frame take place within the first deployment, the learning episodes of the second type occur across several time-frames (i.e., pre-, during, and post-deployment). Both time aspects share similar phases in learning processes: automation, learning-in-action, and after-event learning or unlearning. Depending on the similarity of elements in a context, such as learning cues, resources and drivers, learning may be transferred from one context to another.

In light of the data collected, the original models proposed in Chapter 2 were revised. The following sections discuss the revised models: the informal workplace learning model, the adaptive implicit learning model, and the indicators of disparities that drive learning transfer.

Model A: Integrated Informal Learning Model for a Polar Workplace

Amended from the model of Illeris (2004), the Informal Workplace Learning Model (Figure 5, Chapter 1) offers general categories of learning factors in order to capture a wide range of learning issues reported by the respondents. Apart from introducing the physical learning environment as a factor to the original model, no significant change was made in light of the findings presented in Chapter 3. In other words, physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments and individual factors cover the essential elements of informal learning in a polar workplace. The perceptions of I.C.E. conditions, such as the use of spaces, small group attributes, and a lack of clear border between work and non-work, raise a common need for privacy and resources for working, and living in a polar workplace. The findings indicate that support personnel are more concerned about organisational factors than are scientists during a polar deployment. This is most likely because support personnel live and work in a much more structured environment than field scientists.

The findings in this study also demonstrate the interrelationships among task, emotional and social learning in I.C.E. conditions. Social and emotional learning appear to affect task learning. This is likely due to the closeness of working and living in I.C.E. conditions, especially with respect to not having a break away from work colleagues. Unlike in a conventional environment, where individuals may have the opportunities to seek support of many kinds, or time to refresh mental and emotional states, social and emotional demands may influence task learning. Equally, success or failure to carry out one's duties to a personal standard will have an impact on emotions and, occasionally, social functioning. The limitations on resources that polar workers face with regard to their job make these impacts more likely than would be so in a conventional environment.

Compared with task and emotional learning, social learning appears to be the most dynamic "lesson" for most respondents. Emotional learning appears to embed in the act of learning, and hence requires relatively more effort to recall than do task and social learning. This indicates the importance of good rapport during an investigation of this type of knowledge. Evident from the transfer of learning content and learning processes reported by the respondents, these forms of unintentional, situational, experiential learning seem to be associated with

individual factors, such as time, emotion, construct of a narrative identity, context intensity and learning intensity, and pre- and during deployment experiences. Model A (see Figure 15), which is a revision of the model in Chapter 1 (see Figure 5), provides a framework for the investigation of informal workplace learning factors in a polar workplace. The following sections will discuss the components of this general model.

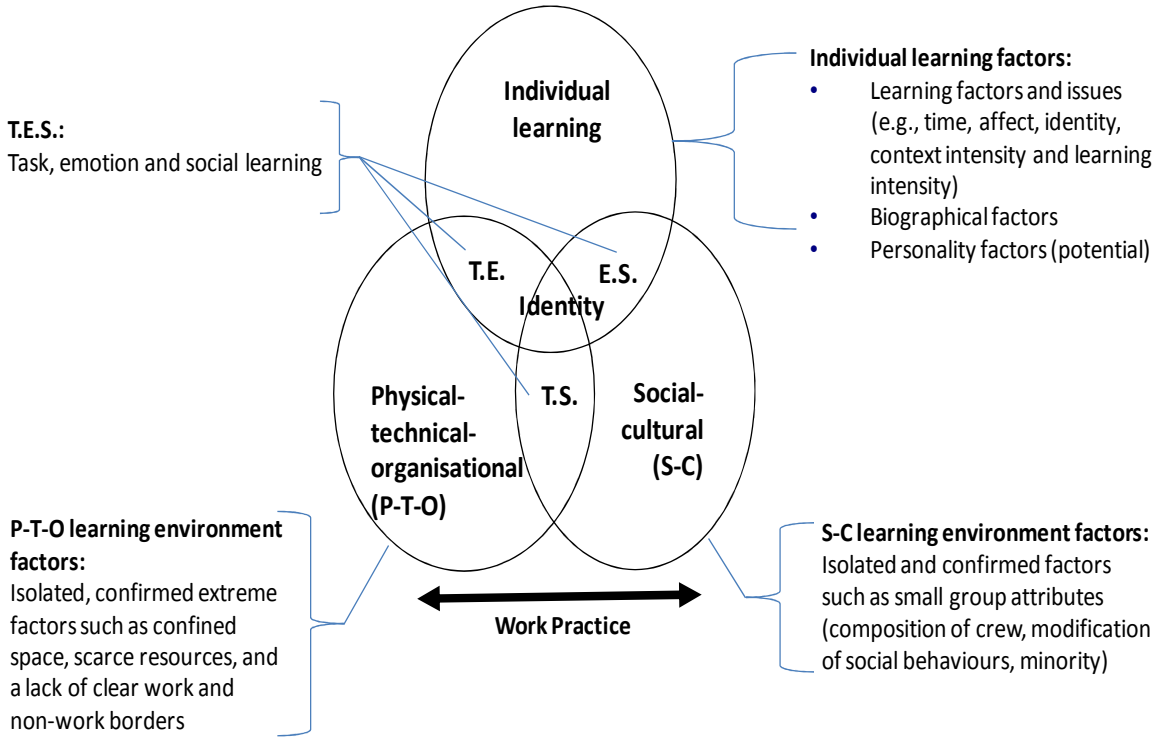


Figure 15:

Model A - Integrated Informal Learning Model for a Polar Workplace

Model B - Revised Adaptive Implicit Learning Model for People on Polar Deployment

The frequency, abstractness and the ease of reportability of task, emotional and social learning content and process varied across time and learners. Overall, though, these findings propose that learning processes embed in learning content. As well, instead of a static entity, consciousness of an implicit learning process may be a personal, subjective, graded and dynamic process. This echoes research and theory proposed by others (Block, 1995, 1999, 2005; Cleeremans & Jiménez, 2001). By taking into consideration the interplay between the perspective of a learner and a learning context across time, the original implicit learning model (Figure 6) proposed in Chapter 1 was modified. Instead of dissecting learning factors into parts, this new learning model (Figure 13, p. 80) recommends examining the learning experiences of a learner as a whole in order to capture the experiences of the learner.

The original model suggested taking into consideration the relationships between learning and the awareness of what was learned across time (Frensch & Rünger, 2003). In this revised model, however, the *exposure to learning environment* is replaced by the *conscious awareness of learning cue(s)* perceived by an individual. That is, although the learning environment provides a framework for implicit learning, exposure to the environment does not per se reinforce learning. It is conscious awareness of a learning cue that drives learning. The fact that *time* is defined as two time-frames perceived differently by the respondents indicates individuals' variation in the conscious awareness of a learning event across time. Findings in this study also indicate Block's model of consciousness (Chapter 1) may explain the many facets of awareness, such as phenomenal, self, assess and monitoring consciousness (e.g., Block, 1995, 1999, 2005; Cleeremans & Jiménez, 2001; Rosenthal, 2002).

The findings also led to a need to include a new aspect of the model to cover the disparities for learning transfer (see Table 5). This model takes into consideration the concepts and models of Learning related Emotional Effects from 'Novice' to 'Expert' (Figure 7, Chapter 1) and learning transfer (Schunk, 2008). The following discussion introduces these models in light of the findings.

Proposed Indicators of Disparities for Learning Transfer

As demonstrated in Chapter 3, specific push and/or pull factors perceived by an individual trigger individual learning. Learning occurs when there is a "*perceived need"* to close a *learning gap* between two conditions. Table 5 highlights the gaps in learning in three dimensions: learning environment factors, learner factors and learning process factors.

Following the theories of identical elements (Thorndike & Woodworth, 1901) and types of transfer (Schunk, 2008; Schunk & Zimmerman, 2008), the current study proposes that some learning begins in a "mindless fashion" (Schunk, 2008, p. 213), whereas other learning is more intentionally entered into when one recognizes a number of features that are common or dissimilar to two learning contexts. These features include a learning situation, a learning effect or a learning process (Schunk, 2008). Although all of these features are described separately, below, they interrelate in most learning experiences in the current study. Originally established for a more controlled learning environment, such as an academic setting or a training context, Schunk's model of learning transfer may apply to a less controlled environment, such as a polar workplace.

From a *situation-perspective*, the degree of similarity between two *learning situations* affects the transfer of learning; *near transfer* refers to a high degree of similarity, *far transfer* relates to a low degree of similarity. Findings in the current study demonstrate that *far transfer* is more likely to incur a shift of learning paradigm, such as learning principles and methods, compared with *near transfer*.

From the *effect-perspective*, transfer of learning depends on the consequence of using past learning for present learning in three forms. Past learning reinforces subsequent learning, either positively or negatively. Positive reinforcement encourages transfer. Negative reinforcement decreases chances of transfer. The second way suggests past learning may serve either as a building block (*horizontal effects)* or just an enhancement (*vertical effects*) for a subsequent learning. Though the first type of effect proposes past learning experience is a pre-requisite for new or subsequent learning, the second type of effect advocates that a new learning does not necessarily require a past experience. The last form of effect put forward is that one may transfer a past learning as a whole (*literal effects*) or in part (*figural effects*) for subsequent learning.

Finally, *process-perspective* suggests learning may also transfer according to the degree of intention (*high or low road transfer*) and direction (*forward or backward reaching*) among past, present or future learning contexts.

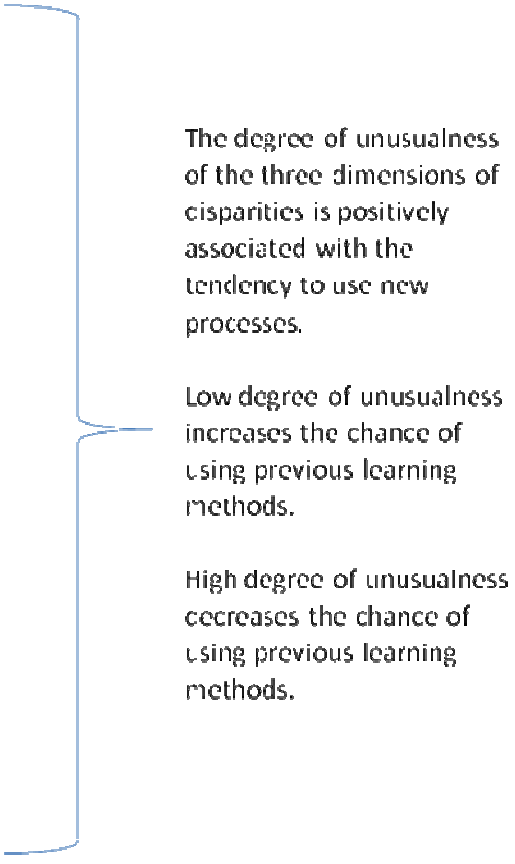
The findings in the current study demonstrate all the above aspects. Learning occurs when there is a *need* to close a *learning gap* between two conditions, regardless of the degree of awareness of such transfer at the time of learning-in-action. These learning needs appear to initiate the transfer of a learning experience or knowledge from one context to another. For one group of respondents, the focus is on the transfer of a *learning process, method, principle and mental model* used across polar and non-polar contexts (see the outer line in Figure 14, Chapter 3). A second

group concentrates on the transfer of *learning content* (see the inner line in the same figure). Overall, most respondents appear to be more content-oriented (focused on a *learning content)* rather than process-oriented (focused on a *learning process),* particularly during the early stage of their learning.

The findings in this study also show the differences between what is needed to be learnt and what knowledge and processes are available at the point of learning-in-action. The disparity of learning proposed in Table 5, below, demonstrates the possible factors that may affect transfer of learning across contexts. The degree of disparities is related to Schunk's near and far transfer. Though a low level of difference between these factors leads to a routine approach to learning, a high level of variance increases the likelihood of using a novel learning principle or mental model for the present learning.

Table 5: Proposed Indicators of Disparities for Learning Transfer in a Polar Environment

	Indices of Disparities (or the Gaps in Learning)
1	**Dimension 1: Learning Environment Factors** Previous environments versus polar environments: i.physical-technical-organisational (P-T-O) i .social-cultural (S-C) i i.context intensity iv.learning demands v.learning resources
2	**Dimension 2: Learner Factors** i.Individual characteristics i .Learning awareness and perceptions i i.Learning needs and affects iv.Learning methods and preferences v.Novices or old hands to the current learning situation
3	**Dimension 3: Learning Process Factors** i.Duration of a learning incident i .Interval between two learning incidents i i.Intensity of learning iv.Learning transfer (adapted from D. H. Schunk, 2008) •Situation-perspective •Effect-perspective •Process-perspective



Apart from the learning environment factors highlighted earlier in this chapter, individual factors may serve as learning cues and drivers of learning. Depending on the types and complexity of learning content to be acquired, as well as the learning resources available, an individual's learning experiences may serve as a base for new learning needs (Kvavilashvili & Fisher, 2007). An individual may report a disparity or a 'gap' of learning when he or she detects an identical or non-identical factor between a 'past' and a 'present' learning situation. Individuals, however, differ in terms of the degree of conscious awareness of these situational cues at the time of learning and at the time of reasoning and expressing their learning.

Findings in this study also confirm the general pattern of emotional outcomes when one transforms from being a novice to becoming an expert (see Figure 7, Chapter 1). During the *elaboration* stage, an individual may experience a range of emotions surrounding *safety*, such as anxiety, curiosity, interest, excitement and confidence (Simons & Ruijters, 2004). These emotions may trigger learning and reinforce an individual psychologically throughout a learning process. The findings in the current study, however, suggest that the term *expert* is more appropriately defined as a person who is conscious of a learning content or a learning process rather than someone who has extensive exposure to polar workplaces. In some cases, this awareness may be demonstrated in his or her learning behaviour. A similar rationale applies to the term *novice*. Although *novices* may have less experience in a polar environment, they may not necessarily be new to a specific learning content. This applies to individuals who have prior experience in other I.C.E. environments or similar learning contexts.

Although it is beyond the scope of this study to investigate the influence of personality on implicit learning, some respondents reported that personality may determine the choices of learning methods and principles related to task, emotional and social learning.

4.3 Implications of Task, Emotional and Social Learning for Polar Psychology

A recent review of Antarctic psychology research by Norris, Paton and Ayton (2010) suggested research psychology to date has yet to capture adjustment factors across the phases of a deployment. This section compares and contrasts the findings of task, emotional and social learning content between the current study and previous findings in polar psychology. In view of the new results associated with learning processes of these types of knowledge, the last part of this section will discuss the theoretical implications of these findings for I.C.E. environments.

According to the respondents, task, emotional and social knowledge cover all essential knowledge require for a polar workplace. Like past polar findings reviewed in Chapter 1, learning content reported concerned individuals' work, psychological and social adaptation issues during a deployment. In the current study, deprivation of privacy, resources and space appears to reinforce implicit learning of a wide range of task, emotional and social knowledge in polar workplaces. Without venturing into an enormous collection of polar and psychology literature about space (e.g., Altman, 1975; McCoy, 2002; Lee & Brand, 2005; Leather et al., 2010), privacy and small group attributes (e.g., Altman, 1975, Suedfeld, 1987; Postmes et al., 2005), as well as scarce resources (e.g., Eraut, 2010), this section discusses the learning perspectives of these themes.

The first aspect looks at the roles of the learning process. Different from the majority of past studies that focus on learning *content* associated with task, emotional and social knowledge in polar literature, respondents in the current study went beyond the first polar deployment to explain how the *process* of learning, especially transfer of knowledge, took place across various contexts. This finding highlights the central nature of learning processes in implicit learning. Paradoxically, they appeared to be overshadowed by learning content in the conscious mind of the respondents. Upon simple or complex reflection, however, these processes may surface more explicitly and be verbalized.

The second aspect highlights the roles of perception in learning. For example, perception of crew composition and group dynamics in I.C.E. conditions makes social learning a complex, dynamic, interactive process; while an individual observes and modifies his or her social behaviour, so do the people around him or her. Various situation cues may trigger one's "need" to modify his or her own learning and work methods, perception and psychological state, self-image and social behaviour, in order to function relevantly within a context. These situation cues include, but are not limited to, a sense of being a minority in a social and work condition (in terms of sex, age, personality and polar experience), competing needs and resources, as well as a lack of borders between work and non-work.

The current study also introduces new concepts: context intensity and learning intensity; they are interrelated for learning to take place. The first type of intensity stems from the demands of the learning environment. In the current study, c*ontext intensity* refers to a sense of intensity that one may feel within a learning environment. The degree of I.C.E. conditions, in terms of the physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments, varied across remote and normal field sites, vessels and stations.

Context intensity is high in both the summer and winter deployments. The intensities in both polar seasons, however, differ qualitatively. Learning environments during a polar summer are characterised by short deployment, fast pace and a greater number of interpersonal relationships, often characterised by lower levels of intimacy. There is, as well, an urgency to fit in, in order to accomplish one's personal and professional goals. Learning environments during a polar winter feature longer deployment, a slower pace, and relatively fewer but deeper interpersonal relationships. It is clear that learning cues in these two seasons are qualitatively different.

The decrease in number of personnel over the winter may drive an increased need to "fit in" with the group. As social intensity and dependency of work and non-work demands appear to be higher in an I.C.E. workplace compared with non-I.C.E. environments, individuals may modify their social behaviour by using inductive and/or deductive methods to achieve group identity within a small community. This echoes the concepts proposed by others (Postmes et al., 2005) for more settings that are conventional.

This suggests that group dynamics in homogeneous crews may differ from heterogeneous crews. In the current study, group dynamics appear to be affected by the formation of informal groups, communication, one's sense of belonging, identities and the need for different forms of space. This finding indicates future investigations should look into polar adaptation in various sizes and levels of diversity in order to map polar adaptation findings on a theoretical landscape. This framework may help individuals and organisations to facilitate workplace adjustment and to improve the quality of information processing and decision-making in small group conditions.

A striking finding arises from the fact that context intensity may be affected by the perceived "unusualness" of the circumstances, such as scarce physical and social resources, including having one's own space and normal social contacts. Stressors intensify when an individual finds it difficult to reframe his or her work conditions or modify his or her own social behaviours or perceptions in order to fit into new work conditions. This form of intensity gives rise to high learning demand and, often, the adoption or creation of new learning processes. Individuals with similar, but not necessarily identical prior experience reported a low degree of unusualness and a near transfer of learning. Depending on the learning demands, one's needs, and the learning intensity to close a learning gap during a deployment, individuals either transfer prior learning across contexts or they learn in-situ. Though some of these learnings transfer from non-polar environments to polar environments, others operate in the opposite direction.

As mentioned earlier in this section, the current study differs from the past polar findings in the sense that it focuses on the interplay between learning content and the processes to acquire the content in a polar workplace. Although a 'user-friendly manual' that describes a list of learning content and the ways to acquire them may satisfy the desires of management, the complex, interdependent, and idiosyncratic nature, of polar implicit learning suggests that such a 'manual' may fail to facilitate self-regulated learning during a polar deployment. At least three rationales, below, contribute to this view.

First, no deployment conditions are identical at all times, at least not to the same degree of I.C.E. conditions. This study suggests the physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments of a polar workplace may change dramatically across polar seasons. These changes include both work and non-work conditions, such as crew composition, operational practices and social dynamics. Although the unique nature of I.C.E. environments presents opportunities for the acquisition of tacit knowledge, what, how and why individuals learn may differ according to personal factors, such as their prior learning experiences and perception of polar learning environments as well as the learning drivers discussed in Chapter 3 and in the earlier part of Chapter 4.

Second, if one's world view of a learning event is affected by his or her biographic and professional background (e.g., Elms, 1995; Jørgensen & Warring, 2001; Hodkinson et al., 2004; McAdams & Adler, 2010), then one's cognitive and emotional state may vary across time. It is, therefore, not surprising that a piece of tacit knowledge that works for one person may not necessarily be applicable to another. Likewise, tacit knowledge that works for an individual at a particular time may not always work for him or her in another time when his or her set of experiences has changed.

The dynamics of a polar learning process examined in this study supports the organic, complex and transitional nature of learning transfer, in general, from one context to another, as discussed by others (Block, 1995; Dienes & Altmann, 1997; Cherniss et al., 1998; Cleeremans & Jiménez, 2001; Haskell, 2001; Frensch & Rünger, 2003; Merriam & Leaby, 2005). Each gap of learning in Table 5, above, may present a unique set of challenges for learning and the transfer of learning across contexts and time (see Figure 13). Models A and B, and the information presented in Table 5, demonstrate the breadth of scope of polar learning phenomena.

Although Model B, the core model of this study, shows a general pattern of implicit learning across time and contexts, these processes are subjective and personal. As some aspects of

tacit knowledge are interrelated, learning takes place under competing priorities and limited resources. This learning is more intensively acquired (and may lead to greater awareness) in I.C.E. conditions compared with a conventional environment. The degree of learning intensity, however, varies by individuals' perceptions of the I.C.E. conditions. Conscious moment of a learning cue alters a learning curve, as proposed in Model B (Figure 13).

Learning content appears to transform according to learning cues and processes, although some participants may not be aware of this shift. However, this is not to say that this automation process of learning is passive and beyond the control of a learner in all situations. It merely indicates that this stage of learning may be "unwitting" because the learner may not register this learning act intentionally in his or her memory, at least not at the time when the learning takes place. This claim aligns with the claim made by researchers who suggested that implicit learning studies should focus not only on awareness, but on other criteria, such as the role of intention during the learning, and the comparison between task demands during learning and the subsequent use of that knowledge (e.g., Whittlesea & Dorken 1997; Cleeremans at el., 1998; Marsch et al., 2006). Those who appear to adopt this view examined learning issues more specifically from the perspective of learning transfer (e.g., Schunk, 2008, Schunk & Zimmerman, 2008).

4.4 Recommendations for Future Research and Applications

The discussion so far proposes a new integrated informal workplace learning model (revision of Figure 5), Model A, that comprises Model B (revision of Figure 6) and Table 5. The first part of this section proposes the areas and approaches for future research. The second part of this section provides recommendations based on the revised models and the findings that led to those revisions.

Recommendations for Future Research

It would be beneficial for future research to employ a more rigorously controlled, longitudinal approach to studying implicit learning in polar workplace(s).

Instead of a single round of data collection, the first option would be to expand the current study by examining selected groups at different intervals over a longer period. Given access to studying selected subjects, it would be beneficial to collect data pre-, during, and post-deployment, in order to examine the way that learning may vary across time. This might include an observation

of learning-in-action *in situ* during a polar deployment, or multiple observations of the same subjects across polar seasons.

A second option would be to replicate the current research with culturally heterogeneous groups in other national Antarctic programmes. This approach enables investigation of implicit learning of tacit knowledge in cross-cultural settings. It would also be worthwhile to study people deployed to other I.C.E. environments, such as remote Arctic sites. This method enables comparison of the contributing factors to implicit learning of tacit knowledge across groups of samples and I.C.E. contexts. It would also allow a wider test of the three learning models proposed in Section 4.2, particularly with regard to more diverse demographic characteristics.

Another option refers to the choice of studying a different breadth of learning; either a wider range of tacit knowledge or specific, pre-defined task, emotional and social knowledge of selected groups of sample, in a pre-defined time-frame and/or learning environment. As an extension of the current research, the study of a narrower range of tacit knowledge may help to identity other potential factors, such as the relationship between "polar personalities" and individual learning preferences (Elms, 1995; Leahey & Harris, 1997; Bradley, 2005). A specific focus on a pre-defined social learning environment may permit an examination of micro-scale social interaction using a symbolic interactionist (Blumer, 1986) approach. In doing so, however, one will, as in the current study, face similar trade-offs between microscopic and macroscopic foci of tacit knowledge.

It would also be constructive to employ direct observation of learning behaviour, as proposed in the initial research plan in Section 2.2, above. This would lend greater comparability to past, laboratory-based research, as well as providing a check on recalled experiences. With proper ethical clearance, organisational data, such as the employee performance records, should be collected as comparisons or validation measures to supplement the first-person data. Such measures were not available to the researcher in this study. Apart from expanding the study of implicit learning at an organisational level, these approaches may address some of the methodological issues related to implicit learning (see Section 1.3.3, Chapter 2). For example, future studies may explore the possibility of using more than one measure of awareness, such as trial-by-trial confidence ratings or guessing criterion of awareness, in order to test which would be a better way of measuring implicit learning at a workplace.

Last, future research should also look into the possibility of using a secured, online recruitment and questionnaire instead of the questionnaire-by-post method, in order to reach out to a wider range of occupational groups, professional and social habitats, and support personnel.

The suggestions in this sub-section coincide with an observation made by Mathews (1997) regarding the approach to studying implicit learning:

> *"Additional research that emphasises high levels of skills in control of complex systems may reveal greater adaptive power of implicit processes. Nevertheless, such research may require less methodological purity and more emphasis on synthesis of theoretical ideas rather than analysis into pure cases."* (p. 38)"

Applications of the Findings

The data suggest that similar content is implicitly acquired by different personnel from season to season. The participants, however, indicated that there is a lack of awareness and development of this form of learning at the organisational level. Many resources are expended in training that is more formal; little appears to be aimed at facilitating implicitly learned content to become more explicit. This is especially apparent with regard to social and emotional learning.

The findings and models in this study offer human resource professionals an alternative way beyond the current approaches (e.g., selection and formal training) to influence workplace learning – and, possibly, performance – during a polar deployment. Management may use Model A (Informal Workplace Learning), Model B (the Adaptive Implicit Learning model) and Table 5 (Indicators of Disparities for Learning Transfer) to identify specific elements of physical-technical-organisational (P-T-O) and social-cultural (S-C) learning environments in order to facilitate shifts of implicit knowledge to explicit knowledge.

Nevertheless, it has to be clear that these models serve as diagnostic tools, rather than as a "manual" that converts tacit knowledge into explicit knowledge for organisational use (see Figure 1, Chapter 1). As Antarctic programmes and organisations, as well as polar deployments, may vary in terms of their learning demands, needs and resources, it is essential to conduct organisational studies in order to assess, design and implement this form of organisational change. An organisation is a complex 'organism' that has imprints and a personality of its own (DeSimone & Harris, 1998; Nonaka & Toyama, 2003; Burke & Cooper, 2008; Busch, 2008). Through careful assessment of the current organisational systems, cultures and practices (Nonaka & Toyama, 2003;

Busch, 2008), management can decide how to best tailor and apply the proposed learning models for their specific organisational needs and context.

Because management of an organisation may be performance-oriented, rather than process-oriented, a change agent who would like to introduce and apply the findings of the current study to other organisations may have to quantify informal learning into return-of-investment of labour and operational costs. To do so, a change agent may have to convert 'implicit learning of tacit knowledge' to measurable organisational outcomes, such as return-of-investment in human resource or polar deployment practices, in, for example, Antarctic organisations, research agencies, universities and military organisations. One of the methods is to link the findings in the current study to performance appraisal and reward systems, as well as training and development practices in these organisations.

For example, a training manager in an Antarctic organisation may apply Model A (Informal Workplace Learning) in conducting Training Needs Assessment (Noe, 2009), such as Person-, Task- and Organisational Analysis, in order to identify and match trainees with suitable training programme(s) and to facilitate their informal learning at a workplace. Additionally, a trainer may employ Model B (the Adaptive Implicit Learning model) to design training content, positive training environments, conditions, and methods of delivery and assessment to facilitate individual learning and on-the-job training. Lastly, a trainer, training manager and management of an Antarctic programme may apply Table 5 (Indicators of Disparities for Learning Transfer) to design and facilitate training and working environmental factors in order to increase the chances of training transfer, and informal learning transfer, across contexts. By using Cost-Benefit Analysis to evaluate and to validate training programmes and/or informal learning activities at a workplace, these change agents may measure different levels of training effectiveness, namely, Level 1 (Reaction), Level 2 (Learning), Level 3 (Behaviour), Level 4 (Result), and Level 5 (Return-of-Investment) (Noe, 2009). By determining the return-of-investment in human resource practices associated to a polar deployment, such as training, job analysis and job design, performance measurement, and recruitment and selection, these change agents may demonstrate, strategically, the applications of the learning models to the management of these organisations.

Equally important is that organisations be aware that many of the features of I.C.E. environments encourage implicit learning. Therefore, altering features in such an environment may have impacts on subsequent implicit learning and later conversion to explicit knowledge. These features include the perception of scarce resources, confined spaces, small group attributes, and a

lack of a clear borderline between work and non-work. At an individual level, awareness of the features covered in Model B and Table 5 may enable sojourners to increase their own awareness of learning issues, demands, disparities and cues. This awareness can take place before, during and after a polar deployment. In other words, these models have the potential to enable self-directed learning by allowing sojourners to alter their own learning processes, approaches and preferences, in order to acquire a piece of knowledge or transfer it across contexts. By taking into consideration the dimensions proposed in Table 5, sojourners can become aware of how their learnt content and processes may transfer, or how learning curves may change, across situations and time.

However, an increase in self-awareness of one's own learning is a double-edged sword when one fails to adjust psychologically to meet a learning demand. According to Self-Regulatory Theory (Doerr & Baumeister, 2010), three constituents are essential for self-regulation to function: a realistic and ideal standard, an ability to self-monitor one's own state of mind and behaviour, and an aptitude to align the current condition with the standard identified. Failure to do so may result in negative emotion and impact on the subsequent learning (Schunk, 2008; Doerr & Baumeister, 2010). In the I.C.E. workplace, the inability to self-regulate, due to lack of physical, social, or emotional resources, may result in "underregulation" or "misregulation"; both states refer to a failure of self-regulating energy or resources in an appropriate level or direction that can result in a generation of a negative affect (Doerr & Baumeister*,* 2010, p. 75). In other words, self-regulation and psychological well-being show interdependent, or "bidirectional" relationships (Doerr & Baumeister , 2010, p. 77). Thus, the features and aspects of Model B and Table 5 may also serve as a diagnostic tool for individual effects as well as organisational effects. However, further research will have to be conducted to assess the effectiveness of cognitive or behavioural interventions, such as self-regulation strategies and skills, based on the findings in this study.

Utilisation of these models by individuals needs to be done with caution, however. As individuals may vary in terms of work and life learning experiences, personalities and motivations, it is not appropriate or efficient to assume that every sojourner is at the same stage of learning at the time of their first, second, or tenth deployment. The findings clearly indicate that there is wide variability in the acquisition and transfer of knowledge within and across deployments.

The findings also show that I.C.E. environments not only encourage but may also require flexibility in terms of learning processes. The static knowledge that can be captured in a 'user friendly manual' may provide general knowledge or guidelines about which tacit knowledge is needed at a workplace, but this manual may not capture or edify sojourners how to act, learn or

think flexibly in dynamic conditions. Understanding one's own learning processes is one of the critical keys to solving task, emotional and social related challenges in a polar workplace.

Because this research was conducted in a primarily New Zealand cultural context and a decidedly unusual physical environment (the polar region), it is recommended that these findings be investigated cross-culturally in other Antarctic programmes, and in other I.C.E. environments. Currently, much social science research is being conducted in each of the polar regions, but often independently (Hovelsrud & Krupnik, 2006; http://ipy-osc.no/). The research conducted in this study is one example of the type of investigation that could be easily extended to both polar regions. This would obviously require a supportive system that encourages collaboration amongst polar social science researchers. As well, the models offered here are necessarily general, rather than specific to a particular location. They need to be tested for their generalisability in other I.C.E. and conventional workplaces. These environments include remote areas in the Arctic regions, remote drilling and mining fields, and military deployment. Characteristics of such environments, it has been proposed, may make them similar psychologically to the Antarctic setting (Suedfeld, 1987; Suedfeld & Steel, 2000).

In a review of Antarctic psychology literature, Norris, Paton and Ayton (2010) suggested that polar research has yet to capture adjustment factors across the phases of a deployment. Before the present study, no publication had looked into how the learning experiences of a deployment may affect individuals' learning before, during and after a deployment. As knowledge workers, Antarctic sojourners conduct cutting-edge science in a most exclusive place, one that is becoming important in a global context. Attention to the manner in which knowledge is acquired in such a place is clearly necessary. This thesis has demonstrated that implicit learning is an important aspect of this process.

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Appendix A
Research Package

Environment, Society and Design Division
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Lincoln University 7647
New Zealand

Telephone: (64) (3) 325 3838 x8662
Fax: (64) (3) 325 3857
Mobile: 021 0278 6478
Email: tanc@lincoln.ac.nz

Lincoln University
Te Whare Wānaka o Aoraki
Social Science, Parks, Recreation and Tourism Group - 6th Floor, Forbes Building

Date:
Re: Invitation to Participate in Polar Research

Dear _____,

Greetings. You are invited to participate as a subject in a project entitled "Balancing on Ice: The implicit learning of tacit knowledge in polar environments" for the purpose of the doctoral thesis undertaken by Ms Chiu-Pih Tan. The aim of this project is to find out which factors are associated with the acquisition and utilisation of tacit knowledge by the polar expeditioners (e.g., support personnel and scientists) in research stations, field sites, or research vessels in Antarctica or polar waters. Your learning experiences on the Ice are unique and valuable, especially to those who have not been there. Your participation in this project would be very much appreciated. It will contribute to the body of scientific knowledge and lead to a healthier and more positive polar working environment.

There are two ways in which you can participate. The first is "Questionnaire-only", in which you would simply fill out a questionnaire regarding some of the things you have learned while on the Ice. The second form of participation would involve completing the questionnaire and a follow-up interview about your experiences. The interview normally lasts approximately an hour, depending on the amount of information the participant chooses to discuss.

If you are at all interested in participating, please:

1) read the *Research Information Sheet* that provides details of the research project
2) complete and return *the Questionnaire and Consent Form* at your earliest convenience by_____. If you choose to complete the softcopy of the questionnaire, it is recommended that you keep a copy for your records before emailing to: _____ (then please send the signed copy of consent form to the following address). Alternatively, please mail the hardcopy to:

Ms. Chiu-Pih Tan
Faculty of Environment, Society and Design
Lincoln University
P.O. Box 84, Lincoln 7647, Canterbury, New Zealand

Thank you for your participation in this project. I look forward to receiving your reply.
Warm regards,
Chiu-Pih Tan (Researcher)
Faculty of Environment, Society and Design
Lincoln University, P.O. Box 84, Lincoln 7647, Canterbury, New Zealand
Email: chiu-pih.tan@lincolnuni.ac.nz

Lincoln University
Faculty of Environment, Society and Design Division

Research Information Sheet

You are invited to participate as a subject in a project entitled "Balancing on Ice: The implicit learning of tacit knowledge in polar environments" for the purpose of the doctoral thesis undertaken by Chiu-Pih Tan. The aim of this project is to find out what factors are associated with the acquisition and utilisation of tacit knowledge in research stations, remote field sites, or research vessels in Antarctica or polar waters.

Your initial participation in this project will involve approximately 60 minutes of your time. This is the core portion of the research. However, if you wish to add value to your data by participating in the interview portion of the study, then the total time will be approximately 2 to 3 hours. The various components of the study are briefly described below:

1) completing a questionnaire on demographic information, personality and *"learning on the Ice"*
2) for those that choose to participate more fully: a follow-up interview, either by phone or face-to-face. Where possible, this interview will be recorded using a digital audio recorder.

Participants may also elect to provide additional information, at their own discretion, that relates to the content covered in this study. This information may take a variety of different forms (photographs, drawings, written accounts), but will not be sought explicitly by the researcher. There are no risks foreseen in the performance of the tasks and application of the procedures.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation. To ensure anonymity and confidentiality, each questionnaire will be numbered and these numbers, not names, used in the analysis. The identities of participants will not be made public without their consent. Participants will be assigned a code that will be used in filing and analysing the data and used in any publication. Pseudonyms will be used in any report. Care will be taken not to use as examples any comments that could be lead to any participant being identified. No information specifically about you, or that can identify you, will be provided to any Antarctic programme without your express permission (if applicable).

Your participation is voluntary. You can elect not to participate and this will have no effect on your current or future job status with any Antarctic programme (if applicable). You may also choose not to answer any particular question, and you can withdraw your information at anytime throughout the study, up to 30 November 2009.

Contact details of the research team:

Researcher:
Chiu-Pih Tan
Faculty of Environment, Society and Design
Lincoln University
P.O. Box 84, Lincoln 7647
Canterbury, New Zealand
Email: chiu-pih.tan@lincolnuni.ac.nz
Mobile: XXX XXXX XXXX

Supervisor:
Dr Gary Steel
Faculty of Environment, Society and Design
Lincoln University
P.O. Box 85, Canterbury, New Zealand
Email: gary.steel@lincoln.ac.nz
Business Tel.: 03 325 2811 ext 8785

The project has been reviewed and approved by Lincoln University Human Ethics Committee.

Consent Form

Name of Project:
Balancing on Ice: The implicit learning of tacit knowledge in polar environments

I have read and understood the description of the above-named project. On this basis, I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided before 30 November 2009.

Please put a √ in the box(es) for those parts of the study in which you are willing to participate:
☐ Part 1: Yes, I am interested in completing the questionnaire.
☐ Part 2: Yes, I am interested in participating in the follow-up interview (after completing Part 1).
☐ Part 3: Yes, I am interested in providing additional information, at my own discretion, that relates to the three abilities. *Note to participant: The type of information you provide is up to you (e.g., photographs, drawings, and written accounts). You may provide this information during Part 1 or Part 2.*

Name (Last, First name): _____

Contact details:

Home/ Office Telephone (including country and area code):_____

Mobile Phone (including country and area code): _____

Email Address: _____

Mailing Address (please include the postal code and country):

_____

Signed: _____ Date: _____

Instruction For Participant:
Please complete and return *the Questionnaire and Consent Form* at your earliest convenience by the date stated on the cover letter. If you choose to complete the softcopy of the questionnaire, it is recommended that you keep a copy for your records before emailing to: cptan06@yahoo.com (then please return the signed copy of consent form to the following address). Alternatively, please mail the hardcopy to:

Ms. Chiu-Pih Tan
Faculty of Environment, Society and Design
Lincoln University
P.O. Box 84, Lincoln 7647, Canterbury, New Zealand

Questionnaire

Instructions For Participant:

This form is to be used for the purpose of the doctoral thesis, titled "Balancing on Ice: The implicit learning of tacit knowledge in polar environments", undertaken by Chiu-Pih Tan. If you have any questions about your participation, or this form, please feel free to contact Chiu-Pih Tan at her email address, or by telephone (XXX XXXX XXXX). Please use the following instructions to complete and return the form:

Completing the Form

Step 1: There are 6 sections in this questionnaire (Section A-F). Please read the instructions and answer ALL questions in this Questionnaire.

Step 2: Type your answer in the space provided for Section A to F. For Section A-E, feel free to write as much or as little as you feel necessary. Please clearly label each answer with the number of the question to which it refers.

Returning the Form:

Step 3: Please complete and return *the Questionnaire and Consent Form* at your earliest convenience by the date stated on the cover letter. If you choose to complete the softcopy of the questionnaire, it is recommended that you keep a copy for your records before emailing to: cptan06@yahoo.com (then please return the signed copy of consent form to the following address). Alternatively, please mail the hardcopy to:

Ms. Chiu-Pih Tan
Faculty of Environment, Society and Design
Lincoln University
P.O. Box 84, Lincoln 7647
Canterbury, New Zealand

Questionnaire

Section A: Demographic Information

1. (a) Please put a √ in the appropriate box: Gender: ☐ Male ☐ Female
   (b) Your age at last birthday: _____ years
   (c) Current occupation:_____

2. Please put a √ in appropriate box and complete the information where applicable.

	Name of research station(s)/ field site(s)/ vessels & your job title	Date(s) of arrival on Ice (DD/ MM/ YR)	Date(s) of departure from Ice (DD/ MM/ YR)	Size of the expedition team (No of people)
☐ I am a former polar expeditioner who has been deployed to the Ice between October 1988 and March 2008. For your first deployment to the polar environment:				
☐ I am current polar expeditioner who is deployed to the Ice between March 2008 and October 2009. For your first deployment to the polar environment:				

3. For both groups:

a) I have spent approximately _____ weeks on the Ice (or on research vessel in polar environments, if applicable) over the course of _____ deployments.

b) I was last deployed to the Ice (on research vessel in polar environments, if applicable) between ____/_____/_____ and ____/_____/_____.
(day / month / year) (day / month / year)

For Sections B-D of the questionnaire, please type your answer below each question. Feel free to write as much or as little as you feel necessary.

Section B: Work, emotions, and social life

Please answer the questions in this section based on your first deployment working and living in Antarctica (or on the research vessel in polar environments, if applicable).

4. Please briefly describe your job on the Ice (or on the research vessel in polar environments, if applicable) (i.e., your general tasks, duties, and responsibilities).

_____

_____

_____

_____

_____

5. Please describe the nature of your emotions during your stay on the Ice (or on the research vessel in polar environments, if applicable). I am specifically interested in the frequency and depth of changes, the tone of the emotions (pleasantness or unpleasantness), and how lightly or strongly you felt emotions.

_____

_____

_____

_____

_____

6. Please briefly describe your social interactions while you were on the Ice (or on the research vessel in polar environments, if applicable). In particular, please address the amount of time spent socialising, types of social activities in which you took part, the number of friends you had, and the depth of relationships.

_____

_____

_____

_____

_____

Section C: Learning on the Ice (Work, emotion and social life)

The purpose of this section is to describe some of the things you learned without being taught or told by someone else during your first deployment to the Ice (or on the research vessel in polar environments, if applicable).

I would like you to describe six instances in which you learned something about living on the Ice (or on the research vessel in polar environments, if applicable). For each of the THREE categories listed (i.e. task, emotions, and social life), describe TWO learning experiences you had during your first-deployment to Antarctica (or on the research vessel in polar environments, if applicable). In each case, please address the following questions:

i) Circumstances
- Under what circumstances did you learn this?
- How often did these circumstances arise while you were in Antarctica (or on the research vessel in polar environments, if applicable)?

ii) Process
- Please describe the process through which you learned this (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways)

iii) Behaviours
- Were you aware that you had learned something new during the first set of circumstances?
- If not, when and how did you become aware of it?

iv) Back home and subsequent deployment(s) (if applicable)
- Would the way you learned it on the Ice be different than the way you would learn something in that category at home and subsequent deployment(s) (if applicable)?
- If so, in what way(s) would it differ? Why?

Note:
Write as little or as much as you like. You do not need to fill up the lines under each section but, if you need more room to answer, feel free to insert another page.

Categories

7a. Something I learned about *work* (1):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

7b. Something I learned about *work* (2):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

8a. Something I learned about *emotions* (1):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

8b. Something I learned about *emotions* (2):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

9a. Something I learned about *social life* (1):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

9b. Something I learned about *social life* (1):

Circumstances:

_____

_____

_____

_____

_____

Process (e.g., trial-and-error, observation of other people, reflection, talking to others, reading, any other ways):

_____

_____

_____

_____

_____

Behaviours:

_____

_____

_____

_____

_____

Back home and subsequent deployment(s) (if applicable):

_____

_____

_____

_____

_____

Section D: Overall Experience

10. In addition to the learning experiences mentioned above, what piece(s) of advice would you pass along to someone who plans to work and live on the Ice (or on the research vessel in polar environments, if applicable)?

_____

_____

_____

_____

_____

11. What forms of support, not already mentioned, were important to the way you learned to meet the challenges on the Ice (or on the research vessel in polar environments, if applicable)?

_____

_____

_____

_____

_____

Appendix B
Sample Questions for a Follow-up Interview

Can you identify and describe a specific example when such lesson is first learnt by yourself during the first deployment?

1) Identified challenges:
   - What happened?
   - How often did this happen?

2) Strategies to deal with the problem first time:
   - What did you do to deal with it?
   - How did you learn to deal with it in this way?

3) Learning behaviours during the first trial:
   - Did you learn to deal with it in this way during the first trial?
   - If yes, how and why? If no how why?

4) Strategies to deal with the problem in subsequent trial(s):
   - What did you do to deal with it when it happened again the second time? third time?
   - How did you learn to deal with it in this way?

5) Learning behaviours during second and third trials:
   - How did you learn to deal with it in this way during your second and third trial?
   - If yes, how and why? If no, how and why?

6) Off-the-ice learning behaviours:
   - Why did you say so?
   - How did you learn about this?

7) Will/ was your learning approach be different after this learning experience:
   - On the subsequent deployment(s)?
   - Off-the-ice?

8) How did you become aware of this?
   Note: This question depends on the learning method(s) identified by the respondent, such as:
   - personal experience
   - trial-and-error
   - observation
   - reflection
   - talking to others
   - readings
   - any other ways